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SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME XXIV FEBRUARY, 1917 NUMBER 2

# FASCIA AND FAT TRANSPLANTATIONS[1]

BY DEAN LEWIS, M.D., F.A.C.S., CHICAGO

SINCE Kirschner in 1909 published the results of his experimental work upon the direct transplantation of fascia, this material has been used extensively in many different fields of surgery. The stimulus given to plastic surgery by the demonstration of the feasibility of the direct transplantation of fascia aroused interest in the direct transplantation of fat, for in certain types of plastic surgery both materials have to be transplanted together or the fat must be transplanted first to prepare for the direct transplantation of fascia.

Fascia is an ideal material for transplantation. The amount is relatively inexhaustible. Enough fascia can be removed for any plastic work that has to be undertaken without interfering with the function of the part. Fascia is so thin that it is easily permeated by serum, little or no degenerative changes occurring after direct transplantation. Fascia also has great strength, for it has been demonstrated that a loop of fascia fastened in a vise will sustain a weight of 90 pounds, without breaking, the ends of the fascia slipping from the vise first. A loop of periosteum fixed in the same way breaks under a weight of 13 pounds.

All the experimental work which has been done demonstrates conclusively that fascia transplanted under suitable conditions into subcutaneous fat or into muscles remains viable. It is not encapsulated like a foreign body, neither is it infiltrated by leucocytes, nor do the nuclei and fibrillæ lose the staining reactions ordinarily shown by living tissues.

It is important to determine whether or not fascia undergoes cicatricial contraction when transplanted, for if such should occur to any great extent, the field of fascial transplantation would be distinctly limited. Fascia contracts somewhat on being removed from its bed, and a piece of fascia lata is usually smaller than the bed from which it is removed. This is sometimes called the primary contraction. Lewis and Davis observed that fascia transplanted subcutaneously, unless fixed by suture, tended to roll up in a ball, but when examined histologically this tissue did not present any evidences of cicatricial changes. In order to determine whether or not fascia undergoes so-called secondary or cicatricial contraction, Kolb placed pieces of fascia about the bowel of experimental animals and found that contraction of the fascial bands occurred, which caused intestinal obstruction. In these experiments another factor, the peritoneum, is introduced, and I believe that the changes in the fascia are secondary to peritoneal trauma followed by scar formation. This so-called secondary or cicatricial contraction has been emphasized by Kredel and has been regarded by him as an argument against the use of fascia as material for tubulization after neurolysis. This will be discussed later under the subject of nerve repair and neurolysis.

[1] Read before the Clinical Congress of Surgeons of North America, Philadelphia, October, 1916.

Fig. 1. Repair of common extensors by tendon transplantation. The skin flap covering the dorsum of the hand has been taken from the abdomen. The entire thickness of the subcutaneous fat is taken with the skin graft, so that normal fat can be used for the tunnels through which the fascial or tendon transplants are inserted and through which they play. In this case all the common extensor tendons had been destroyed when the hand was caught in a hot roller used in a laundry.

Fig. 2. Skin and fat graft from the abdomen to cover large defect on back of hand. This injury was caused by the hand being caught in a hot roller. Fascial grafts were inserted in tunnels made through the fat. This was an almost hopeless case for the interphalangeal joints were opened, and there was considerable ankylosis of these joints.

REPAIR AND RECONSTRUCTION OF TENDONS

Reconstruction of tendons by bridges of catgut, silk, or silver has never been entirely satisfactory, for pressure-necrosis of the skin often followed the insertion of the foreign material and proliferating neighboring tissues have in some cases invaded the bridge and limited the function of the newly-formed tendon. This criticism applies particularly to the reconstruction of tendons lost as the result of infection or trauma. The advantage of the direct transplantation of tendons in the repair of tendon defects has been especially emphasized by Rehn. There are some disadvantages in the use of tendon as a direct transplant. The amount of tendon that can be used for direct transplantation without seriously interfering with function is small. The tendon of the palmaris longus is practically the only one that can be used and the amount furnished by these two tendons would not be enough for the reconstruction of a number of tendons; as for example, when the common extensors of the fingers have been destroyed. The objection has also been made that tendon when transplanted undergoes degeneration in the deeper parts as indicated by a collection of leucocytes and the poor staining reaction of nuclei and fibrillæ. Kirschner in particular has emphasized these changes, and believes that these are more or less permanent for he does not think that the peritendineum externum and internum repairs this degenerated tissue, for the peritendineum has, according to him, no specific function in repair such as the periosteum has. He attempted to divide tendon which he would transplant into small pieces in order to secure better nutrition, but this was impractical.

Transplanted tendon behaves differently, depending upon whether or not functional activity is assumed early. The principle announecd by Roux that the fate of transplants, providing that ordinary biologic laws have been observed, is dependent largely upon whether the funstion for which the tissue was originally intended, has been assumed early is often overlooked when discussing the fate of transplanted tissue. This principle is so beautifully illustrated in the case of tendon transplant that I would like to review the changes occurring in tendon transplanted subcutaneously and into a defect in a tendon which is made to assume function early, for these changes indicate procedures which should be followed in both tendon and fascial transplantation if success is to be attained. Pieces of tendon transplanted subcutaneously tend to shrink. When removed some five weeks after transplantation, they are found to be but one-third as large as when placed in a tendon defect and made to functionate. Although such pieces can be easily identified as, and have all the physical properties of,

Fig. 3. Tenolysis for adhesions following an electric burn. Flexor tendons at the wrist were adherent to a dense scar so that fingers were fixed in an extended position. Flexor tendons were dissected free, and separated by thin fat grafts. The scar was dissected out and a graft with considerable fat was transplanted from the abdomen. Later some of the fat was removed from this graft. While flexion is still limited, the patient has been able to resume his work as a lineman and is quite satisfied with the result.

tendon, except for a considerable loss of luster, they show no proliferative changes in the peritendineum as do transplants which have been made to assume function early. Microscopic examination of tendon transplanted into subcutaneous fat shows that the fibrillæ and nuclei stain well, and that the segment may be regarded as viable. There is, however, some leucocytic infiltration, and no evidence of proliferative change. Such a transplant may be compared to a paralyzed limb. It is alive and has circulation, but it has become shrunken.

The changes occurring in a transplanted tendon made to functionate early relate mostly to size and form. At the end of seven days a transplanted segment which has not increased much in size lies in a mantle of grayish red granulation tissue which is usually separated from the transplant proper by a delicate layer of connective tissue. At the end of seventeen days a transplanted segment is definitely enlarged and the surrounding layer of granulation tissue has formed rather intimate union with it. At the end of three weeks the transplanted segment is two to three times as thick as the tendon on the opposite side. The transplanted segment becomes fusiform and no longer tapers to the point of attachment as does the normal tendon. The transplant is usually widest at the middle, there being a gradual reduction in size to the line of suture at either extremity.

All these changes are most marked in the

Fig. 4. Cross section of a piece of fascia from the rectus abdominis transplanted into the subcutaneous fat of the abdomen and removed 23 days later. This fascia is alive, there is no leucocytic or round-cell infiltration, and no evidence of absorption of the transplant. (Lewis and Davis.)

third week after transplantation. They are quite marked, however, as late at five weeks. They are due to proliferative changes in the tissues surrounding the transplant, in the peritendineum externum and internum, as well as to an œdema in the transplant resulting from an imperfect re-establishment of circulation. While some regressive changes occur in all transplanted tendon segments, as evidenced by some of the fibrillæ undergoing hyaline degeneration, the transplant as a whole remains viable. The transplanted segment does not act as a bridge to convey tenoblasts from the proximal to the distal end of the resected tendon, and the formation of new tissue in a transplant, when it has undergone some regressive changes, takes place from the tissues of the transplant itself.

The difference in behavior between pieces of tendon transplanted into a tendon defect or into subcutaneous fat, cannot be due to differences in nourishment, for tendon transplanted intramuscularly or subcutaneously has as favorable conditions provided for its nourishment as that transplanted into a tendon defect. The real difference, it seems to me, is that in one instance the tendon as-

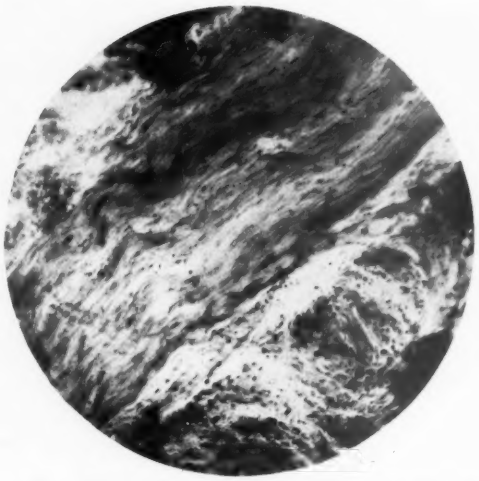

Fig. 5. Longitudinal section of a piece of fascia removed from the rectus abdominis and transplanted into a subcutaneous pocket of the abdominal wall. Fascia examined 35 days after transplantation. (Lewis and Davis.)

sumes early the function for which it is intended, while in the other it is permitted to undergo an atrophy, quite comparable to disuse atrophy, which eventually ends in death and absorption.

Fig. 6. Longitudinal section through a tendon three weeks after transplantation. The fibrillæ and nuclei stain well and appear practically normal. There are some proliferative changes in the peritendineum. (Lewis and Davis.)

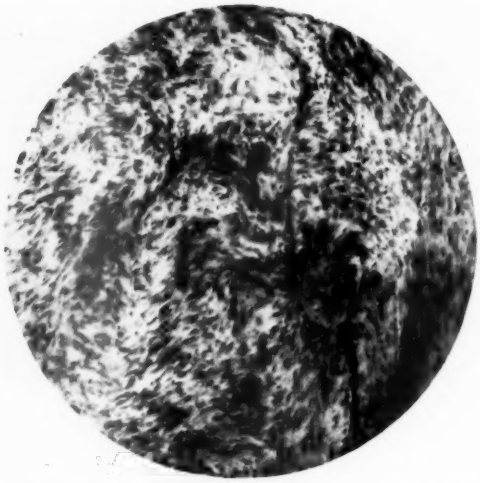

Fig. 7. Cross section through a piece of tendon transplanted into the subcutaneous fat and removed after five weeks. Piece of tendon reduced considerably in size. There is considerable leucocytic infiltration in certain areas. Neither the fibrillæ nor peritendineum show any changes. These definite degenerative changes are probably due to the fact that this piece of transplanted tendon has not been made to assume function. (Lewis and Davis.)

Fascia lata is a tendon and the same changes occur in it as in a tendon transplant but to a less extent. I believe that it is preferable to tendon for transplantation in the repair of tendon defects because it can be obtained in such large amounts and removed without interfering with function, and in the repair of extensor tendons the strip can be made to correspond in size and form to the tendon to be repaired.

As the repair of tendons is usually required after extensive burns, lacerations, or infections associated with much scar tissue, the transplantation of a flap of skin containing considerable fat is usually first required. In the repair of extensor tendons it is best to transplant a flap from the abdomen, containing considerable fat. I have taken the entire thickness of the fat, sacrificing cosmetic for functional results, which are more certain when this amount of fat is taken. Fascial transplantation is not attempted until the flap is entirely healed. Then the fat is tunneled through with artery forceps so that the transplant will run through a fatty tunnel.

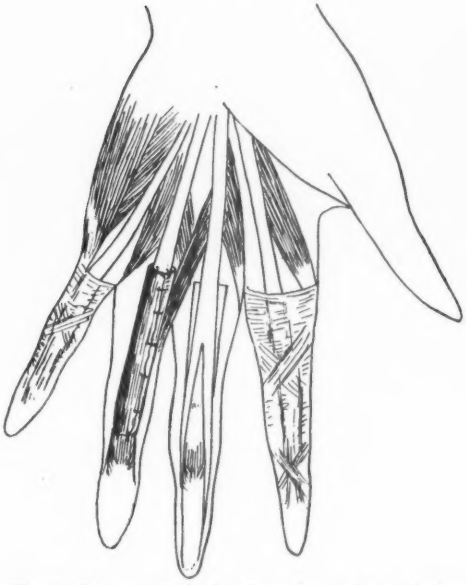

Fig. 8. Diagrammatic sketch to show tube made from fascia lata which surrounds the proximal ends of tendons to be repaired and is attached distally to the periosteum of the phalanx.

As previously stated early assumption of function is of prime importance in securing functional results and active motion should be encouraged as soon as the patient can undertake it. This is rarely possible before two or three days, because of the pain associated with motion. The suture that should be used in such cases must hold the ends well approximated when the muscles are thrown into action, and must not strangulate the tissues. The suture introduced by Frisch answers the purpose better than any I know of. Kimura has demonstrated experimentally the strength of different types of tendon sutures. He found that the Frisch stitch never tore out when the weight was below 355 ounces and that it withstood considerable traction from 3 to 15 hours, while the other types of tendon suture never withstood a weight much less than this over two hours.

The results following the repair of flexor tendons are not as satisfactory as those following the repair of the extensors. The play of the flexor tendons is greater than that of the extensors and they are grouped so much more closely in the palm that slight adhesions may interfere seriously with function. The technical difficulties are also increased when the transplantation is carried high into the palm.

Fig. 9. Tendon which formed following operation. The finger was amputated 255 days after the fascial tube was inserted. The fascia remains intact, forming a sheath for the tendon which has developed from the proximal end of the flexor sublimis and profundus tendons. The two tendons separated by a thin connective-tissue septum can be distinguished in the tube.

I have attempted fascial transplantation in the repair of tendons when the skin on the

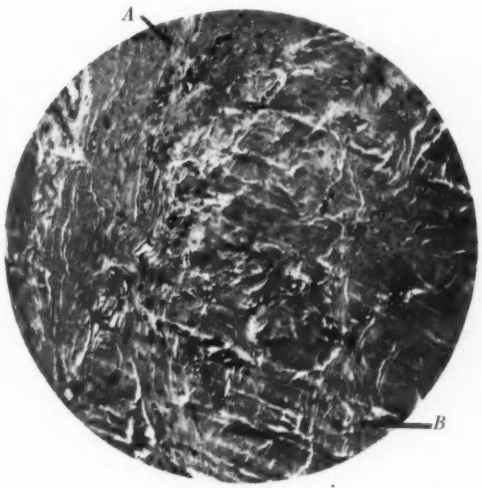


Fig. 10. Cross section of the tendon. The fascia well preserved and resembling normal fascia forms a sheath for the tendon which has developed. There is no evidence that the fascial tube plays an active part in the formation of tendon. It forms merely a canal along which the tenoblasts of the divided tendon proliferate. *A* Section through transplanted fascia; *B* section through new tendon. The fat which lined the inner side of the tube and which would, it was hoped, form a sheath, has disappeared.

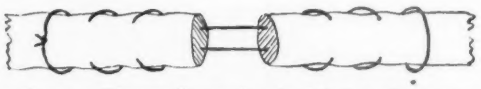

Fig. 11. Diagram illustrating the Frisch tendon suture. This suture holds the sutured ends closely approximated. It is so applied that it does not interfere much with the nutrition of the tendon and holds so firmly that active motion can be begun early. The pain induced by motion is usually so severe at first, that attempts to use the sutured tendon will not be made until the second or third day. Early assumption of function is necessary if good results are to be obtained in tendon repair by fascial transplantation. When fascial tubes are used in reconstruction this suture will have to be modified somewhat.

flexor side of the finger was closely adherent to the bone, and necrosis of the skin has occurred. In such cases I believe it much better to remove this skin with the associated scar and do a skin transplantation first, including considerable fat in the skin flap. The entire flap should not be raised when the fascial tube, which is preferable to the fascial strip, is inserted; but small incisions should be made at the side of the phalanx and the tube inserted after a good sized tunnel has been made in the subcutaneous fat.

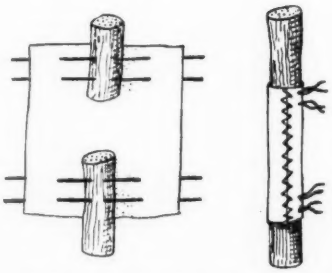

Fig. 12. Diagram illustrating method of constructing a fascial tube to bridge a nerve defect. The nerve-ends should be placed in such a position that corresponding parts of the surfaces of the two ends lie opposite each other. (Kirk and Lewis.)

I have had the opportunity of examining the fate of a fascial tube which was inserted for the repair of the flexor tendons of the ring finger. The patient who was a physician, had been bitten by a patient upon the ring finger of the right hand fourteen months before entering the hospital. A severe infection developed so that thirteen days after the injury the terminal phalanx and a part of the middle phalanx with the flexor tendons

Fig. 13. Section of the tip of the distal end of a resected nerve tubulized by fascia showing the invasion of the serum which has filled the tube by protoplasmic bands formed by proliferation of the neurilemmal cells. The greater part of the growth of these bands takes place from the proximal end of the nerve. These bands form conduits down which the developing axis cylinders track. All axis cylinder formation takes place from the proximal end of the nerve. (Kirk and Lewis.)

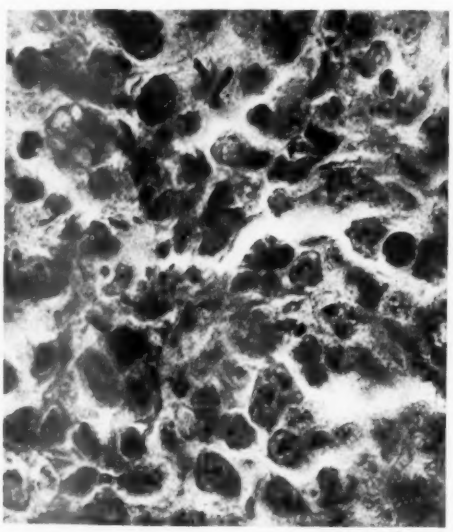

Fig. 14. Section of upper part of gap following resection of a nerve and tubulization with fascia, showing proliferation of neurilemmal cells and invasion of protoplasmic bands by axis cylinders, eight days after operation. (Kirk and Lewis.)

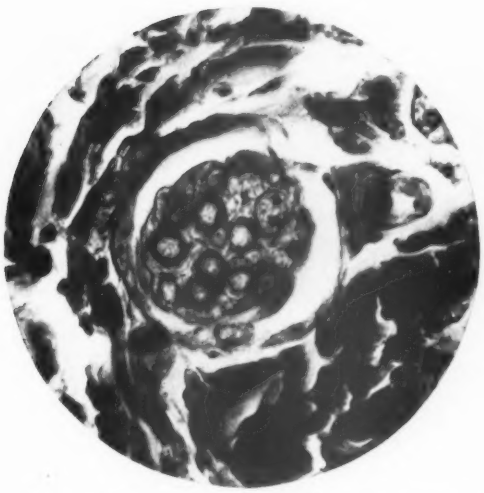

Fig. 15. Section of upper part of regenerated intermediate segment seven weeks after operation showing formation of myelin sheaths, the last stage of complete nerve repair. (Kirk and Lewis.)

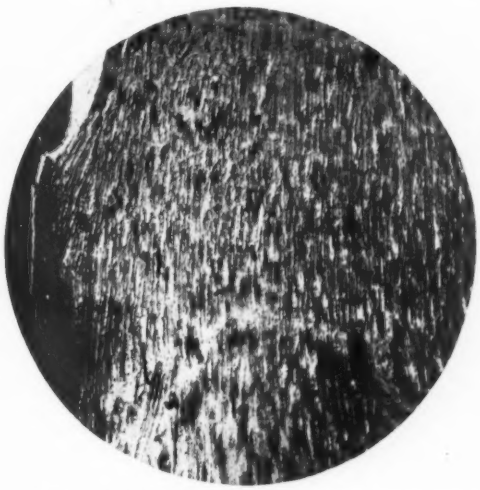

Fig. 16. Distal segment of resected nerve seven weeks after operation, showing amount of invasion of this segment by axis cylinders which have bridged the gap. (Kirk and Lewis.)

had to be removed. The wound continued to discharge for two months. At the time I first saw the patient, scars were present upon the anterior and posterior surfaces of the ring finger which extended to the middle of the hand and down to the proximal transverse fold. The ends of the flexor tendons could be felt.

I attempted to reconstruct these tendons by means of a fascial tube. A piece of fascia including a layer of fat measuring about 3 inches in length and one-half inch in width was removed from the fascia lata of the right thigh. A flap was then dissected up from the

Fig. 17*A*. Appearance of nerve removed seven weeks after fascial tubulization to repair a defect, reduced one-half. Lines indicate approximate extent of fascial tube. *B*, same specimen divided longitudinally. Lines in fascial tube indicate extent of former gap. (Kirk and Lewis.)

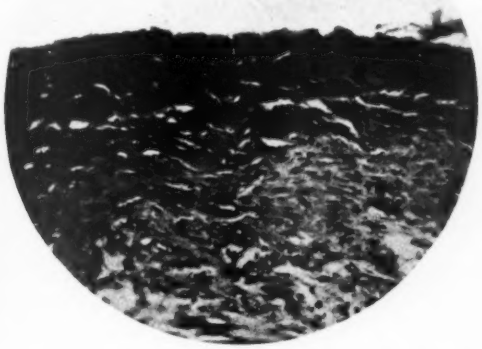

Fig. 18. Histologic appearance of fascia sixteen and one-half weeks after tubulization. This fascia has undergone no cicatricial change and is in the same condition as when transplanted. After this length of time no contraction or replacement of the fascia is to be expected. (Kirk and Lewis.)

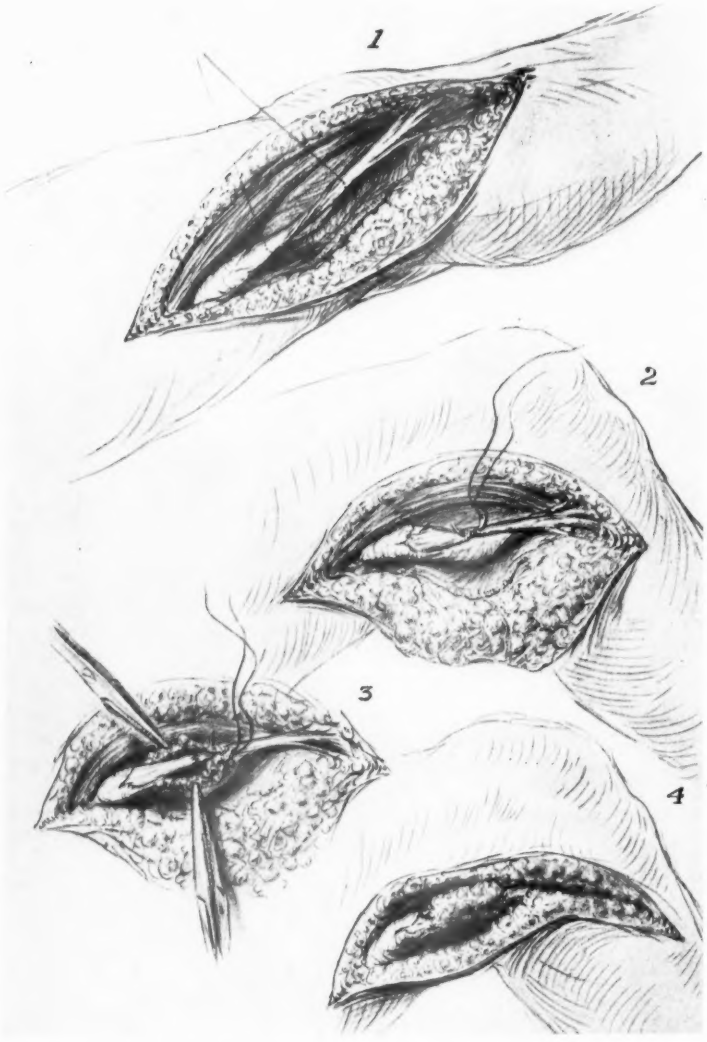


Fig. 19. Neurolysis by direct fat transplantation. The intermediate strand in the external popliteal delimited by the lines is composed mostly of scar tissue. Resection with end-to-end suture is therefore indicated. By flexion of the knee the resected ends could be approximated without tension. A fat transplant was used to protect the suture line against cicatricial contraction. Fat is preferred to fascia in neurolysis because the latter undergoes cicatricial contraction in the presence of a scar. In the majority of cases in which neurolysis is indicated there is considerable scar formation.

palmar surface of the finger, the incision being carried through the interdigital fold into the palm of the hand. The ends of the tendon were dissected free from a dense scar in which they were imbedded, and a fascial tube was formed which surrounded the ends of the tendons on the proximal side and was prolonged to the periosteum of the middle phalanx

distally. The side of the fascia holding the fat was made the inner side of the tube. Active motions were encouraged at once, but these could not be carried out at once because of the pain associated with them. After some weeks the patient could flex the finger to about 80°, when the newly formed tendon was held against the bone. The results were not entirely satisfactory, however, and nine months after this operation I amputated the finger. A newly formed tendon was found, both the flexor sublimis and flexor profundus, separated by a septum, having proliferated down the tube. The fat which formed the inner side of the tube had been absorbed, so that the newly formed tendon was adherent to the fascia, which was fully preserved and did not differ histologically from fascia recently removed.

One of the reasons why the results attending construction of the flexor tendons are not as good as desired is that at the present time we have no satisfactory method of reconstructing the transverse bands, which are usually destroyed in the cases requiring tendon reconstruction. In the case of fascial tube reconstruction just cited, considerable impairment of function was caused by the newly formed tendon, leaving the bone each time flexion was attempted. The patient soon discovered that he could greatly increase the amount of flexion by holding the tendon against the bone when flexion was attempted. Rehn has encountered the same difficulty after transplantation of tendon to repair defects in the flexor tendons. When a ring is worn holding the transplanted tendon down to the bone, the amount of flexion is greatly increased.

McArthur has employed a method in the preparation of a fascial transplant which I believe is of distinct value, as it will lessen the frequency with which secondary tenolysis has to be performed. This procedure tends to render the fat over the fascial transplant more suitable for transplantation. In the plan advised by McArthur, an attempt is made to cover the transplant with condensed, closely adherent fat. The fascial strip which is to be transplanted is first dissected up, but is left attached at both ends. Subcutaneous fat is then placed about this fascial strip and the wound is closed, leaving the fascia with the fat about it lying in its bed. Six weeks later McArthur reopened the wound in the thigh and found the fascial strip covered by abundant closely adherent fat. The fascial and fat transplant was then transferred to the forearm, and sutured to the flexor muscles above and the tendons below. In this case the greater part of the bellies of the flexor muscle had been destroyed by a corn shredder. The results in this case may be considered extremely good. The fingers cannot be flexed individually, but the function of the hand is so much improved that the patient can grasp a pitchfork and work about the farm.

Fascia may be used to advantage in the treatment of paralysis, It may be used as a tendon to transfer the action of an active muscle to a paralyzed part and may be used to fix a muscle to overcome a deformity dependent upon paralysis. Three cases have been reported in which fascia has been used to correct a ptosis. The fascial strip has been attached above to the active frontal portion of the occipito frontalis, and has been passed beneath the skin of the eyelid and sutured to the tarsus. Two of the results (Payr and Muehsam) were apparently successful. In Aizner's case; the operation being performed for correction of congenital ptosis, the fascia apparently underwent cicatricial contraction, for after six months there was some lagophthalmos and the lid space had considerably widened. Lewis and Davis have reported a case of trapezius transplantation in which the trapezius, after being separated from the acromion and spine of the scapula, could not be brought down as far as desired upon the humerus. A wide fascial strip was sutured to the trapezius above and into the humerus below, the arm being held and dressed in abduction at 90°.

Payr in a case of deltoid paralysis split the upper part of the trapezius and sutured fascia to it. The fascia was then sutured to the long head of the biceps below and was fixed over the joint. Rothschild and Cramer have both used fascial transplantation successfully in the correction of trapezius paralysis.

Busch has used fascial transplantation in the correction of facial palsy by the so-called suspension method. In order to correct the drooping of the angle of the mouth, the skin of the cheek is undermined and a fascial strip which is passed beneath it is sutured to the muscles of the angle of the mouth and is fixed above to the periosteum of the zygoma. In a case of facial palsy operated upon by Payr two strips of fascia were used. One piece was fixed above to the infra-orbital margin, the other piece was sutured to the temporal muscle. An excellent result was obtained when the facial muscles were at rest, but no mobility or expression was obtained through the strip attached to the temporal muscle.

FASCIA TRANSPLANTATION IN REPAIR OF NERVE DEFECTS AND FOR NEUROLYSIS

A study of nerve injuries, abundant opportunities for which have been offered by recent wars, has shown that in may cases in which paralysis has developed the nerve has not been completely severed. It has been contused or grooved and the functional disturbance which results is often due to the contraction of cicatricial tissue within or about the nerve. Loss or alteration of function may be due to the secondary involvement in callus or to the stretching over bony points in cases in which nerve is associated with bone injury. A scar fixing a nerve over a bony point may cause marked functional disturbance. In some of these cases paralysis develops late. Paralysis developed in a patient of Borchart's two years after the removal of dead bone from the shaft of the humerus. In many of these cases freeing of the nerve from the scar is enough to secure return of function, providing the scar can be prevented from re-forming.

That neurolysis may be decidedly beneficial is indicated by the cases observed by Hashimoto during the Russo-Japanese war. But four nerve sutures and three nerve transplantations were attempted in the fifty cases operated upon and observed by him. The results of the three cases of nerve transplantation were unsuccessful. In 45 cases neurolysis was attempted. The results were very good in 11 cases, good in 15, satisfactory in 3, questionable in 4, and unsatisfactory in 11. In 7 cases neurolysis was attempted 300 days or more after the injury. In this series the results were good in 4 cases, questionable in 1, and unsatisfactory in 2. In 45 cases treated by neurolysis good results were obtained in 65 per cent, or if the 4 questionable cases are included in 74.4 per cent. The results obtained by neurolysis after 200 days had passed from the time of injury were doubtful.

Many different materials have been used for tubulization after neurolysis. Material used for this purpose must be capable of good sterilization, must not act as a foreign body, and must not contract adhesions with the nerve. Decalcified bone tubules, iodoform gauze, hardened human blood-vessels, human epidermis, magnesium tubes, hardened blood-vessels of calves, have all been used. Hashimoto used calves' arteries hardened in formalin after the method of Foramitti. In one case reported by Hashimoto amputation became necessary four months after tubulization with a hardened artery was attempted. The hardened blood-vessel was almost entirely absorbed, only a few elastic fibers remaining in some places. Where at the first operation a white, avascular cicatricial thickening was found, there was at the second operation a soft reddish segment abundantly supplied with blood-vessels.

Recently there has been considerable discussion against the advisability of using fascia for neurolysis. Kredel has been particularly emphatic against its use because of an experience he had in which the fascia was applied directly about a scar in a nerve. Contraction occurred in the transplanted fascia, necessitating a second operation. But few cases have been reported in which fascia has been used for neurolysis. I have operated upon one case in which the musculospiral nerve was resected and sutured, the line of suture being covered with a fascial transplant. There has been almost complete return of function without any interference in function from contraction. Law has recently reported two cases of brachial plexus injury, in which the line of suture was covered with free fascial

flaps. There has been continued improvement in these cases with no evidence of cicatricial contraction of the fascia. Rowan in a recent personal communication relates the history of an ulnar nerve suture combined with fascial tubulization in which there has been a complete return of function. Against these successes may be mentioned the cases of Kredel and Goldmann. Goldmann placed fascial strips about the median and ulnar nerves. After six months the nerves had to be exposed, because of impairment of function. The fascia was then found to be firmly adherent to the nerves.

Experimentally fascia may be used successfully to bridge a defect in nerves and the results which follow experimental tubulization would indicate that fascia may be used for neurolysis providing the scar is resected. If placed about a recent scar fascia contracts. This contraction, as well as that which occurs in fascia placed about peritoneum is, I believe, not inherent in the fascia proper, but is secondary to the scar existing when the fascia is placed about the nerve.

Kirk and Lewis have examined 41 sciatic nerves of adult dogs, 21 of which were sectioned serially, in which fascia has been used to tubulize a defect. The nerves were examined at periods varying from 1 day to 36 weeks after the operation. In none of these did the fascia forming the tube undergo cicatricial contraction. In some of the late stages the fascia had become so thinned that it was scarcely distinguishable from perineurium.

The changes occurring in a fascial tube used for this purpose would seem to be conducive to cicatricial contraction. During the first day the tube is filled with a serous exudate. If hæmostasis has been adequate, the exudate contains few or no red cells. At the fifth day the portions of the tube nearest to cut ends are filled with a soft grayish white, pulpy material resembling brain matter. This exudate comes from the nerve-ends, the fascia showing no reaction. Even as late as the fourth and fifth days, the middle of the tube may be empty. Experimentally this tube does not collapse, and an excellent opportunity is afforded for the study of regeneration of nerves after tubulization. One of the most striking things revealed by the study of nerve regeneration by this method is that protoplasmic band formation precedes the downgrowth of axis cylinders from the central end, and that while protoplasmic bands develop from both ends of the resected nerve, axis cylinders develop only from the proximal end, and enter the bands which act as conduits for the developing axis cylinders. The approximate rapidity of growth of the bands is indicated by the fact that after removal of a segment of a nerve measuring 12 millimeters in length, the protoplasmic bands have completely bridged the lumen of the tube by the sixth day. The bands are very numerous near the proximal end of the nerve at this time, much less numerous at the distal end and least numerous at a point about 10 millimeters from the proximal end of the resected nerve. This indicates that while protoplasmic band formation occurs at both ends, the formation is much more active at the proximal end, and that the bands forming here grow much more rapidly.

In the late cases examined by us, as late as 36 weeks, there has been no cicatricial contraction which would undoubtedly have occurred after this length of time if such were to take place. The transplanted fascia has in some instances as previously stated become almost indistinguishable from the perineurium. Von Fleischhauer in his clinical observations has found that a cicatrix in a nerve usually undergoes contraction seven or eight weeks after an injury. Fascia cannot be successfully used for neurolysis when it is placed about a scar or in a bed of scar tissue, but it may be used successfully to cover a line of suture in a nerve, and has been so used by both Law and Lewis.

### FAT TRANSPLANTATION IN TENOLYSIS AND NEUROLYSIS

Several objections have been raised against fascia for purposes of neurolysis and tenolysis. As stated above Kredel and Goldmann were compelled to perform a second operation in cases in which fascia had been placed about a nerve. Cicatricial contraction of the fascia; the formation of broad, firm adhesions be-

tween the nerve and the fascia; and fatty degeneration of the fascial transplant with infiltration limit considerably the use of fascia for both neurolysis and tenolysis. Under appropriate conditions fascia may be used for both purposes, but often extensive scars are encountered when these operations are performed and the use of fascia is therefore limited.

Experimentally it has been shown by histologic examination that transplanted fat heals in position with extremely little or no reaction of the foreign body type. There is but little leucocytic infiltration. In the early stages transplanted fat becomes adherent to nerves about which it is placed. During regeneration of the fat the adhesions become less and less and the fat either merely surrounds the nerves or is separated from it by a connective-tissue zone of microscopic width. Eden and Rehn believe, as a result of their experimental studies, that no other autoplastic transplantable material contracts as few adhesions with tissues about which it is placed as fat.

Because of these properties, fat can be transplanted in a much larger proportion of cases of neurolysis and tenolysis than fascia, for in most cases in which the operation is indicated there is considerable scar tissue. In tubulizing for the repair of nerve defects, in which there is considerable scar formation, it is well to take considerable fat with the fascia, the fat being placed upon the outer side of the tube.

### CLOSURE OF DURAL DEFECTS

Most of the attempts which have been made to close dural defects and to prevent scar formation in the cerebral cortex by the use of foreign material have been unsuccessful. The two best materials which have been used to close dural defects are fascia and peritoneum, autoplastic transplants being used. The same changes occur in both after transplantation and also in the brain cortex after their use. The results of experimental work in dural plastics vary. Saar found adhesions between the fascia and pia arachnoid in many of his experiments. In seven of the ten cases examined by him, more or less extensive adhesions were found. It seemed to be the rule that in all cases in which the brain was traumatized adhesions formed between it and the fascial transplant while in cases in which the brain was not injured a space was found between the transplant and brain cortex. In some cases the fascia was covered by endothelium.

Up to 1914, 73 cases had been reported in which fascia lata had been used to close a defect in the dura:

This type of plastic operation was performed for —

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| Traumatic epilepsy | 14 |
| General epilepsy | 12 |
| Brain tumor | 13 |
| Dural tumor | 15 |
| Recent compound skull fracture | 3 |
| Simple skull fracture | 2 |
| Old depressed fracture | 3 |
| Gumma of the brain | 2 |
| Meningocele | 1 |
| Character of injury or disease unknown | 2 |

In 7 of the 73 cases cerebrospinal fluid escaped after the operation. In 5 of these the escape of fluid ceased after a few days. Haberer operated upon a traumatic cyst of the brain in which almost the entire wall of the lateral ventricle was removed and replaced by fascia. Cerebrospinal fluid escaped for one day after this and then the discharge ceased. In one of Eiselberg's cases the discharge of fluid persisted for ten days, at which time the patient died.

In six of the cases the brain prolapsed. In two of these the prolapse occurred after the fascia had been perfectly transplanted. In three the prolapse was probably due to an infection which developed. In one case it was impossible to completely replace the brain after the dura had been removed, and technical difficulties prevented the proper insertion of the fascia.

In none of the cases has enough time elapsed since the operation to permit one to speak positively of the results.

But few opportunities have been had to examine fascia which has been used to close a dural defect in man, and the case reported by Rehn is therefore significant, for it indicates what procedure must be followed if the results are to be improved.

The patient, a male 27 years of age, had

epilepsy, and after removal of a considerable piece of dura which was under pressure, the defect was closed by a fascial transplant. Because of a recurrence of symptoms some five months after the operation, a second operation was performed. The bone flap which was not closely united was turned down and the fascial transplant was then found to be closely adherent to the surface of the brain. A distinct difference between the central and peripheral part of this transplant could be made out by the naked eye. About the periphery, the fascia had retained its histological characteristics, but toward the center of the transplant fewer well stained nuclei were found, phagocytes loaded with pigment became more numerous, and gnarled, rolled up bundles of degenerating fibrillæ, rather sharply delimited from the adjacent living fascia were seen. The dense adhesions which had formed between the brain cortex and the fascial transplant were apparently the result of necrosis in the central part of the fascia, which ended in fatty degeneration followed by cicatricial substitution.

While fascial transplantation closes effectively a dural defect, preventing prolapse of the brain and probably reducing somewhat the chances of infection, it does not fulfill the purpose for which it is frequently employed of preventing adhesions. This has been demonstrated experimentally and clinically. Fat forms much less dense and fewer adhesions and for this reason it is advisable that when a dural plastic becomes necessary, a layer of fat be included with the fascia and that the fat be placed toward the brain cortex. If adhesions do then form, they will be more delicate and pliable than those associated with any other type of dural plastic.

I have operated upon three cases of epilepsy following trauma in which a subdural cyst was found. In these cases the scar which had replaced the dura and formed the outer wall of the cyst was removed. The cavity of the cyst was then filled with a fat transplant and the dural defect closed with a fascial transplant. In two of these cases the seizures have been reduced in frequency and severity, while in the third case no improvement has been noted.

### RECONSTRUCTION OF COMMON BILE-DUCT AND URETER, AND STRENGTHENING OF SUTURE LINES

With the idea of determining the amount of resistance that fascia might have against certain body excretions, Davis and Lewis attempted to reconstruct the common bile-duct with a free fascial transplant. Attempts were made to bridge gaps in the common duct, and to patch partially severed ducts. In all cases the gastrohepatic omentum was destroyed in so far as any support was given the common duct. In one series of cases the common duct was cut across and the ends allowed to retract until they were one-half to one inch apart. A strip of fascia was removed from the rectus muscle, passed beneath the duct, fastened by silk sutures to the proximal portion of the common duct and passed well up on the cystic and hepatic ducts. The repair of the distal end was done by fixing the fascia behind the duodenum, behind the entrance of the distal end of the duct into the intestine. The fascia was then folded to form a tube, and two continuous sutures were used to make the caliber as tight as possible. Over this the omentum was wrapped as an extra precaution.

In the second series the common duct was cut partially across and then slit lengthwise for one-half inch, a strip of fascia from the abdominal wall was placed around the duct and the abdomen closed without drainage. In 11 cases it was necessary to close the abdomen without drainage, as the animals pulled out tubes and gauze in the first 24 hours. In some cases an attempt was made to divert the bile from the field by draining the gall-bladder. The animals died from the escape of bile into the abdominal cavity after the tubes had been removed by them. Leakage rendered the experimental results nil. Three dogs in which the duct was cut lived two months. Two when killed had a patent common duct and the stools were normal in color. The third dog, which lived 65 days, had a constriction on the intestinal side of the common duct, and the duct above this point of constriction was enormously distended. The fascia was, alive however. In one dog in which the duct was cut longitudinally the fascia was sutured too tightly at the duodenal

end, but even in this case the fascia was alive and strong enough to retain bile.

Strauss has demonstrated experimentally that fascia will live in the presence of urine, even when infected. A peculiar ossification of the transplant occurs in the cases in which fascia is used to bridge an ureteral defect. The lumen of the tube is preserved in spite of this ossification, but the ossified segment may interfere with the flow of urine, because of interruption of the peristaltic wave. Fascia may be used to reinforce a suture line of the ureter and one case is reported in which fascia had been placed about a repaired ureter and prevented extravasation of urine after the sutures gave way.

Fat has been used extensively to reinforce suture lines in gastro-intestinal surgery. Braun was the first to use a pedunculated omental flap to reinforce the suture line over a perforated gastric ulcer. Senn early advised the use of omental grafts, free or attached, to reinforce the suture line in gastric and intestinal surgery. In closing perforated gastric ulcers, the suspensory ligament can often be used to reinforce the suture line, for the perforation frequently occurs close to this ligament.

Fascia although advised by Koenig and others to reinforce the suture line in intestinal surgery cannot be used for this purpose, because of its tendency to undergo cicatricial changes, leading to constriction of the intestine or the formation of adhesions with neighboring loop. It is interesting to note, however, that defects of the intestinal wall, which have even included the mucosa, have been closed by a fascial patch. The intestinal mucosa has proliferated in some of these cases so that the inner surface of the fascia has become covered with epithelium.

As fat and fascia can be transplanted with such a fair degree of certainty, both probably have been used in many instances in which there is no necessity for the use of these materials. The use of both fat and fascia after pyelotomy is of doubtful value, for it has been my experience that the wound in the pelvis soon heals, and besides, stitches about the pelvis after the removal of a stone may form the nucleus for a new one. Payr has used successfully in pyelotomy a pedunculated flap from the fibrous capsule of the kidney. If the capsule is so thin that a flap cannot be easily made, a free fascial transplant may be used or a fat transplant.

While free fascial transplants have been used in fixation of the kidney and in orchidopexy, I doubt the necessity or wisdom of employing fascia for these purposes. Because of the size of the transplant required in kidney fixation, fatty degeneration of the transplant with subsequent cicatricial contraction is apt to occur, and the testicle can be usually placed in the scrotum if the shortened vessels are resected and the bands of fibrous tissue which hold the testicle in the inguinal canal are freely severed. In cases in which the testicle cannot be placed in the scrotum after these procedures and maintained there by a purse-string suture passed about the entrance to the scrotum, I doubt the advisability of attempting to save the testicle.

### TRANSPLANTATION OF FAT FOR COSMETIC PURPOSES

It has been stated in discussing tenolysis and neurolysis that the strips of fat usually used for these purposes remain viable. While certain changes occur leading to absorption or liberation of fat droplets, collections of other groups of cells, probably derived from the original fat-cell are found which indicate definite growth changes, so that the term of growth atrophy may not be inappropriately applied to the changes in the fat following transplantation. The possibility of transplanting large masses of fat widens considerably the field of plastic surgery. Czerny was probably the first to attempt the transplantation of large amounts of fat. He reported to the German Surgical Congress in 1895 a successful transplantation of a lipoma to replace a breast which had been removed. Neuber soon after reported cases in which he had transplanted fat subcutaneously to raise a depressed scar over the infra-orbital margin resulting from an earlier tuberculous osteitis. His attempts to transplant large pieces of fat all failed, and he came to the conclusion that pieces of fat which exceeded in size a bean or almond could not be successfully transplanted.

The use of fat to fill bone cavities resulting from osteomyelitis has been frequently attempted, and as is the case with most operations designed to do this, the final result depends upon the amount and virulence of the infection. If the cavity can be so cleaned that the chances of infection are greatly reduced or removed fat may be used to fill the cavity, but the experience with fat transplantation in the closure of osteomyelitic cavities is much like that with the Mosetig-Moorhoff plug and Beck's paste.

Tuffier has used fat transplants to cover the end of the bone after amputation of the femur, after resection of an elbow-joint, etc. In two cases he attempted to close an empyemic cavity by transplanting a lipoma, while in a third he transplanted a piece of omentum which had been kept on ice.

But few attempts have been made to use fat to correct deformities about the face. Bier operated upon a facial hemiatrophy and increased the size of the half of the face affected by inserting strips of fat removed from a lipoma beneath the skin. Neuber used it to raise a depressed scar over the frontal sinus; Kanavel to correct an unsightly scar of the chin which followed ulceration following the application of arsenic paste.

Ophthalmologists have used fat transplantation both after enucleation and evisceration of the eye. All of the uses to which fascia and fat transplantation have been applied have not been touched upon. I have attempted to give some of the underlying principles. The use of fat or fascial transplantation in arthroplasties has recently been the subject of much discussion and their value demonstrated. The use of fascia to occlude intestinal loops in gastro-intestinal surgery, and to produce temporary closure of vessels in the treatment of aneurism has been tried out sufficiently to determine its distinct value in these fields of surgery.

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## FASCIA AND FAT TRANSPLANTATION[1]

By FRANCIS T. STEWART, M.D., Philadelphia

MY experience in transplanting fascia and fat has been limited by lack of confidence, first, on my part, second, on the part of certain of my patients. My distrust in the survival of completely detached portions of fat and fascia was most acute when I first heard of these proceedings, and it was not until after I had seen, notably in connection with arthroplasty, broad sheets of fascia transferred from the thigh to other parts of the body and there retained for months without suppuration that I was willing to venture into this field of plastic surgery. Even after obtaining success in my initial ventures I still hesitated to recommend unconditionally what was to me a new and scarcely tried procedure; hence the lack of confidence on the part of my patients. I told them what I wanted to do and that I was uncertain of the result, consequently many of them refused to submit to what they justly regarded as an experiment. I and they still assume this attitude in regard to the formation of tendons from strands of fascia, so that although I have expressed a willingness to try to make new sinews for a number of maimed patients, none has consented to participate in the trial. Concerning most, but not all, of the other purposes for which free fascial transplantation has been suggested, I am in agreement with the authors of those suggestions, and after what I have heard tonight my opinion must, necessarily, become more positive in the direction of the efficacy of neotenoplasty.

Altogether I have transplanted completely detached pieces of fat, fascia, or fat and fascia about 100 times. In only 5 cases was there suppuration of the wound in which the graft was imbedded. In one of these, a case of inguinal hernia in which operation had already been done several

[1]Discussion of Dr. Dean Lewis's paper read before the Clinical Congress of Surgeons of North America, Philadelphia, October 23–26, 1916.

times, the hernia again recurred. In two others, cases of arthroplasty, a slightly movable joint was obtained despite the formation of pus. In another, a case of congenital fragilitis ossium with an ununited fracture of the femur, the femur united. In this case the fascial graft was wrapped about the femur to maintain in place a trap-door in the bone, which had been elevated in order to permit the introduction of an intramedullary splint. In another case, one of closed tuberculous osteomyelitis of the calcaneum, in which the diseased bone was replaced by fat, a minute sinus formed and still persists at the end of a month. In several other cases a small quantity of serum was evacuated from the wound, without however, delaying its closure. Hence one may conclude that, in a specified operation, e.g., operation for hernia, arthroplasty, the danger of acute necrosis of a free transplant is little or no greater than the danger of suppuration in the same operation without free transplantation. This point should be emphasized since there are still many surgeons who are skeptical as to the benignity and the value of this form of reparative surgery.

In five of my cases the graft or the site of the graft was seen sometime after the operation. Once, in the case of fracture previously mentioned, it was discharged as a slough. Once, in a case of incisional hernia in which death from uræmia occurred a week after operation, it was found only partly and slightly adherent to the tissues of the abdominal wall, it being separated from these tissues in some places by a collection of serum. Once, in a case of suture of the carotid artery followed by a large hæmatoma, it was removed on the second day in order to inspect the sutured wound in the artery, which was found to be dry, the bleeding having proceeded from one of the stitch holes that had been made in fastening the graft to the artery. In this case the grafting produced the very condition it was designed to prevent. Once, in a case of graduated ligation of the carotid artery for pulsating exophthalmos, the transplant with the artery which it enveloped was removed at autopsy three months after operation, the patient having succumbed to an acute nephritis. Macroscopically the transplanted fascia was firmly adherent to but could be differentiated from the arterial wall. The microscopist's report states that "there is a very dense fibrous tissue which is probably the transplanted fascia. Apparently exterior to it is granulation tissue showing considerable lymphocytic infiltration and containing many multinucleated giant cells. This granulation tissue only slightly invades the fascia. The fascia is poor in cells. Apparently there is partial death of the fascial cells." Once, in a case of pyloric occlusion with a fascial graft, the pylorus was inspected at the end of 18 months during the course of a second laparotomy, and found to be imbedded in firm adhesions and apparently non-patulous.

In about one-half of my fascial transplantations the operation was undertaken for the relief of inguinal or ventral hernia.

In those varieties of inguinal hernia in which the usual operations give only mediocre results, e.g., large hernia, recurrence hernia, direct hernia, sliding hernia, fascial transplantation would seem to promise a distinct amelioration in those results, and be superior to the implantation of foreign substances, which not unfrequently give rise to trouble later, and to the borrowing of fascia or muscle from the margins of the defect, which necessarily results in a weakening of those marginal structures. Furthermore when attached flaps are taken from the immediate neighborhood of a hernial ring they cannot be swung into the plane in which they would be of the greatest benefit, i.e., between the transversalis fascia and the peritoneum. This is the point at which a recurrence usually begins, and, having once begun, is seldom restrained by the overlying planes of tissue, even though these planes have been overlapped or otherwise reinforced. When a fascial transplant is sutured on the exterior of the muscles it is at once, to use a military term, outflanked by the recurrence, which follows the line of least resistance along the cord and appears at the external ring. A further advantage of placing the graft beneath all the muscular and fascial layers

is that it is more likely "to take." It should never be placed immediately beneath and in contact with the cutaneous incision, in which situation it is more apt to become infected and suffer elimination. When only a small transplant is desired it can be obtained from the fascia lata just below the outer end of Poupart's ligament between the anterior crural and the external cutaneous nerves, after undermining the lower lip of the cutaneous incision. When a larger and thicker piece is necessary, however, it is better to make a separate incision over the trochanter of the femur. This principle of submural implantation I have followed also in dealing with ventral hernia, suturing the graft beneath the transversalis fascia or, particularly in the upper abdomen, in which region separation of the peritoneum from the transversalis fascia is sometimes tedious, beneath the peritoneum. I believe it to be advisable to remove all fat from the graft when it is to be interstitial, thus encouraging prompt and firm adhesions to the tissues between which it is placed, and to leave the fat and turn the fatty side toward the viscera when the graft is to be placed beneath the parietal peritoneum, thus discouraging adhesions to the under surface of the graft. If the fat is to be removed, this should be done before the graft is excised; otherwise the graft is subjected to increased handling and its journey from its old to its new habitat prolonged, thus violating two of the principles of this form of surgery; viz., minimal brutalization and rapid transportation.

For the purpose of maintaining a near-throsis, non-absorbable non-foreign fascia is surely superior to non-absorbable foreign substances (silver, zinc, celluloid, rubber), which are so often discharged by suppuration, and also to absorbable substances (magnesium, Cargile membrane, chromatized pig's bladder), which are objectionable because they are absorbed, thus permitting the osseous surfaces again to come in contact. However, I believe that for a successful result, as much depends upon the liberal removal of bone and early motion as upon the interposition of any material.

For enveloping a nerve after neuorrhaphy or neurolysis, fat and not fascia should be employed. Fascia generates more adhesions; it also shrinks and compresses the nerve.

Fascia offers a staunch material for reinforcing the suture line after angiorrhaphy, but is probably inferior to muscle as a hæmostatic agent. If one desires both the firmness of fascia and the thrombokinetic influence of muscular tissue, a transplant composed of fascia on one side and muscle on the other can easily be obtained. For the gradual obliteration of a large artery, e.g., common carotid, aorta, a tight and almost occlusive primary wrapping of the vessel with fascia, to be followed at a later period by definitive ligation, is to be preferred to increasing compression by metallic foreign substances.

At first I occluded the pylorus with a free transplant of fascia from the rectus abdominis, but now use the round ligament of the liver.

The largest amount of fat that I have transplanted was to restore the contour of a breast after the removal of a massive fibro-adenoma. A year later the transplant was slightly smaller, more firm, more granular, but the cosmetic result remained unaffected.

# SURGERY OF THE PERIPHERAL NERVES[1]

By C. A. PORTER, M.D., F.A.C.S., Boston

IN preparing this short paper I have studied 187 cases of peripheral nerve lesions which have entered the Massachusetts General Hospital since 1900 or have occurred in private practice. With the exception of a few interesting neuritis cases and old facial paralyses, the origin of the nerve lesions was traumatic. For many years I have been much interested in this subject and in consequence find that I have personally performed more than half the total number of operations. The series covers every peripheral nerve except the cutaneous branches and includes the short saphenous, facial, lingual, and spinal accessory. Before attempting any analysis let me first present the material and the end-results so far as they have been obtained.

*Facial paralysis.* In 4 cases attempts at suture were made: 1 primary after a razor cut, with unknown result; 1 six months after a pistol wound, suture of the eleventh to the seventh nerve no improvement. The third, complete paralysis thirteen years after a convulsion. The facial was split and a slip of the hypoglossal placed in the niche. Fifteen years afterward there is partial recovery. In the fourth case, following a mastoid operation two years before, the facial was anastomosed to half of the hypoglossal. Ten years afterward there are weak voluntary facial movements, though faradic response is good. One-half of the tongue is atrophied and the speech somewhat thick. I have had no personal experience with this operation and shall, therefore, leave to Dr. Frazier the discussion of the best technique in this anastomosis. In my series there is another type of facial paralysis, either congenital or very ancient, from 19 to 36 years, in which all the muscles are permanently atrophied and nerve suture is useless. I have accomplished marked improvement by crescentic incisions of skin and fat over the malar bone, taking up the slack with buried silk sutures. Later a second resection is performed, the scar to fall in the nasolabial fold, well beyond the angle of the mouth. The redundant mucous membrane is removed from the inside of the lips and sutured out of sight. I strongly recommend this operation for all cases of facial paralysis where anastomosis is impossible or unsuccessful.

Turning next to *brachial plexus lesions* we come to a most discouraging subject. As I have never had an opportunity to operate for birth palsy I shall limit myself to accident cases. There are three types: the upper arm, or Erb, the lower arm, or Kluempke, and complete paralysis, depending upon whether the force has crushed the shoulder downward, motor cycle or coasting accidents, or the arm has been caught in a belt and jerked violently upward. There have been 17 cases in which operation was not advised, or was refused; 1 case combined with subclavian laceration, died within 48 hours. In others, lesions of the sympathetic or a probable coexistent lesion in the cord suggested an inoperable condition. In some cases of gunshot injuries or dislocation of the shoulder, it seemed best to await developments. In several instances of the upper-arm type, with a fairly useful hand, exploration was refused by the patient. There were 21 cases in which some sort of an operation was performed, 18 of them by myself. In September, 1901, Dr. Mixter performed the only primary suture of the whole plexus: a cut from broken crockery. The man disappeared after discharge. All combinations of lesions have been found. An absolutely inoperable condition, where the nerve roots of the plexus have been completely torn from the spine, or the fifth and sixth roots ruptured and torn backward; or the inner cord had borne the brunt of the injury, requiring resection of the clavicle for adequate examination. In 1 case operated upon in 1903, four months after the accident, all of the cords found hopelessly blended in a mass of scars were excised and an entirely new plexus constructed, which would defy a

[1] Read before the Clinical Congress of Surgeons of North America, Philadelphia, October 23–26, 1916.

professor of anatomy. In this case flexion of the wrist first began three years after operation, improvement continued, and now, while there is flexion of the arm, wrist, and fingers, and some power in the triceps, the extensors are paralyzed. In three cases amputation of the shoulder was demanded by the patient. In 9 the plexus was dissected free, the scars were incised and cargile membrane, fat, or fascia was used to prevent adhesions.

The average time from accident to exploration was five months, the longest three and one-half years. Upon exposing the brachial plexus, the surgeon is confronted with a mass of scar tissue in which cords and trunks are often indistinguishable. There may be hard nodules in the nerves; perhaps a root or roots cannot be found between the scalene muscles. The fifth cervical or first dorsal may appear intact. What shall be done? Incise? Excise? Anastomose,— if so, to what? Because I have tried to solve this problem so often I am convinced that complete brachial paralysis demands immediate exploration just as much as a perforating wound of the belly. If ruptures exist they should be repaired at once. If the cords have only been stretched they may be incised, bleeding stopped, and further operation delayed until the extent of the damage can be determined.

By comparison the results after musculospiral paralysis are very satisfactory. The nerve has been freed from adhesions or bony callus in 11 cases; with marked improvement in 9; failure in 1; 1 not heard from. There have been 14 sutures; 6 have been successful. In 1913, I transplanted four inches of a dog's sciatic between the ends of the nerve. There has been no improvement. In 2 cases the recent operation of bone plating has been the cause of trouble. In 1 the plate was found screwed to the musculospiral groove, obliterating the nerve for three inches. In another, at the patient's request, the plate was removed at the end of three months from a perfectly united humerus. Wrist-drop followed this operation. The longest case was one of re-suture six years after an unsuccessful union; result unknown, probably failure. One primary suture recovered in eleven months. The usual time is a little more than a year.

Of all the peripheral nerves, the ulnar and median are most often divided owing to the frequency of lacerated wounds of the forearm and wrist. There have been 48 cases of suture; 12, or 25 per cent, coming to the hospital for a primary operation. The average interval was seven and one-half months; the longest five years. A few of the primary sutures have been almost perfect, as has one (three months old) secondary suture of the ulna in the arm three years after the operation. The results of the majority were unsatisfactory, though trophic disturbances have usually been prevented. When we consider that the ulna in particular regulates the fine movements of the hand, the importance of early proper treatment of these wounds becomes obvious. I shall later consider the reasons for failure.

There have been 4 cases of excision of the sciatic nerve; 2 for tumor, 1 without suture, another sutured by the flap method with recurrence of growth and no return of function. I have twice excised nerve bulbs following one and three years after division and suppuration. In 1, end-to-end suture was performed with partial recovery; in the other, too recent for result, a two and one-half inch gap was surrounded by a cuff of fascia lata. If division is below the nerve supply to the ham strings, the only deformity is toe-drop and with proper support for the ankle locomotion is surprisingly good. I have performed 6 sutures of the external popliteal, the first in 1905. In 1, after three years, secondary suture, the motor result is perfect though sensibility is somewhat impaired. In 2 cases the nerve was cut high in the thigh, where it was quite distinct from the internal popliteal. In the other cases the nerve was injured near the head of the fibula. An anastomosis of the external popliteal to the internal last January is too recent for a result.

There have been 7 cases of *Volkmann's paralysis* of the forearm due to too tight splints. In one there was no nerve lesion. Resection of both bones gave a perfect result. In the others the ulna or median or both were strangulated by scar tissue or partially destroyed.

Neurolysis, resection with fascia tubes,

has been followed by partial restoration of function. The operations have shown conclusively that in the majority of these cases there are actually nerve as well as muscle and tendon lesions.

I have operated three times upon the posterior nerve roots, for pain, never with complete success. I feel sure that in addition to the division of the roots forming the brachial plexus that the fourth cervical and second dorsal should also be cut. It is impossible to consider the many interesting cases of miscellaneous nerve injuries, but I wish to say a word about tourniquet paralysis. A rubber tube should never be used about the mid-arm. Even if the arm is padded the nerve may be crushed against the bone. I have seen one case of complete paralysis of the ulnar, median, and musculospiral nerves following excision of the elbow. The result was a real flail joint, for almost a year.

I wish briefly to summarize the reasons for poor results of nerve suture as indicated by a study of the literature and this series of cases:

1. Inadequate examination at the time of injury, and failure to note conditions found, i.e., wrist-drop after fracture of the humerus, or toe-drop after injury to the knee. If the patient can abduct the fingers from the middle line the ulnar is intact, as is the median if the thumb can be opposed to the base of the little finger, not flexed into the palm. Simple tests for sensation; deep sensibility, pin prick, cotton wool, and compass tests, and test for heat and cold require no special skill. Electrical examinations demand a neurologist.

2. Failure to examine for nerve lesions in lacerated wounds of the forearm and wrist, and failure to realize that lack of such examination may mean a maimed hand for life.

3. Exploratory operations should be done oftener and earlier. If a traumatic nerve lesion persists and there is reaction of regeneration in the muscles, or continuation of pain, Nature should not be trusted to bring about recovery. A definite cause will almost always be found and the quicker this is remedied the better the prognosis.

4. Secondary nerve sutures are almost never completely successful. Past suppuration and extensive scar formation are of more importance than the interval between the injury and the operation. Motion may be restored, one, two, perhaps three years after injury, but sensation will never become normal.

5. At operation, scar tissue, whether outside the nerves or within the nerves or between nerve ends, must be got rid of. We have been too conservative. A scar nodule, often better felt than seen, should be excised. The nerve bulb must be thoroughly removed even if end-to-end suture cannot on this account be performed. Inadequate removal has been the cause of failure in many sutures. By traction on the bulb the proximal segment can usually be stretched about an inch. The nerve must then be cut cleanly with a sharp knife.

6. Hetero transplants and any foreign body should be avoided. An excised sensory nerve or fascial tube forms the best scaffold for the growing fibers. A three-inch gap can thus be filled. If the distance is longer, nerve anastomosis is probably better. Flap operations are to be avoided and the distal end should be sewed to divided fibers of the proximal nerve. Sherren has found that a sound nerve can be cut through one-third of its circumference without permanent damage. In end-to-end anastomosis the nerve should be gently grasped with fine toothed forceps, and one or more transfixing sutures of fine silk or chromic catgut inserted through the center of the nerve and loosely tied. The circumferences should then be approximated by fine catgut stitches passed only through the perineurium. Finally, there must be absolute asepsis and careful hæmostasis; no tension. After-treatment is absolutely essential for complete recovery. At first there should be rest, then massage and galvanism should be employed until voluntary motion returns.

If all of these indications are followed I believe that work on the peripheral nerves will prove one of the most interesting and satisfactory fields of surgery.

# SURGERY OF THE PERIPHERAL NERVES[1]

By CHARLES H. FRAZIER, M.D., F.A.C.S., Philadelphia

I HAVE listened with great interest to Dr. Porter's contribution. The opportunities he has had for observation are unusual, the results he has obtained excellent, his discussion is most instructive, and the topic he has chosen for your consideration most timely. The European War has revived our interest in the problems of dealing with injuries of the peripheral nerves, and while numerous contributions have appeared in literature, sufficient time has not yet elapsed for a general "round up" and conclusions at this time can only be surmised.

Many interesting observations have been made during the war did we but have time to discuss them; the peculiar individuality of nerves, the propensity of one to motor disturbance, as the musculospiral, of another to pain, vasomotor and trophic disturbance, as the median; and of another to pain, as the sciatic.

As Americans, we may take pride in the confirmation by the European surgeons of those original observations, made by Weir Mitchell during the Civil War more than half a century ago and recorded in that well-known monograph, as to the difference between neuralgia and causalgia. The latter term Mitchell coined for the excruciating pains, felt chiefly in palms and finger tips and soles of feet (where the touch organs are most abundant) aggravated by heat, emotion and noise, lasting months only to disappear spontaneously, benefited but rarely by operation.

But to turn now to some of the practical phases of the subject of peripheral nerve injuries, the really vital question, as Dr. Porter has indicated, is, given an injured nerve, *when* is operation indicated, and *what* operation gives the best results. Dejerine tells us to operate in all cases presenting the syndrome of complete interruption without signs of regeneration; Auerbach says, immediately after healing of wounds of exit and entrance; and Kirschner in not less than six weeks.

With regard to the time of operation, the experience with gunshot and shell wounds during the present war has proved that it is difficult, if not impossible, in many instances to determine by the most careful examination whether the injury be in the nature of a contusion or laceration. Hence the importance of assuming a conservative attitude by waiting a reasonable time for the resumption of function. If taken within a reasonable time after the injury, that is about two months, the results will be as good as after immediate suture. I recognize the necessity of longer postponement on account of infection; as a matter of fact the results of primary suture are almost as good as those of secondary suture.

After the injured nerve is exposed, how will you deal with it? Here we might delve into speculative theories, involving those of nerve regeneration and restoration of nerve function but to no purpose. For practical purposes it matters not how the cervical sympathetic by union with the phrenic, may cause contraction of the vocal cords, or the cervical sympathetic through the phrenic contraction of the diaphragm, how stimulation of the phrenic through fusion with the cervical sympathetic causes hyperthyroidism (Cannon), how the hypoglossal facial anastomosis restores the complicated movements of expression, how the nerves of a flexor group may innervate an extensor group. In 1906 I carried out a series of animal experiments in which both anterior crural and sciatic nerves were divided and sutured to one another, the central stump of the sciatic sutured to the peripheral stump of the anterior crural and vice versa, and I was amazed to see how soon function was restored despite the confusion to the central nervous system.

The whole question of the method or modus operandi of impulse transference after nerve anastomosis or implantation is one of more than academic interest, but very difficult of solution because we know so little about

[1] Discussion of Dr. C. A. Porter's paper read before the Clinical Congress of Surgeons of North America, Philadelphia, October 23–26, 1916.

the real character and mode of conduction of nerve impulses under normal conditions. It scarcely seems plausible that coaptation of fiber bundle for fiber bundle is essential to a satisfactory nerve suture, as Stoffel and several others advocate, in a recent report on nerve injuries in the present war, since this is practically always impossible and the results of nerve suture are often very good. Moreover, experimental work has shown that the results of suture of two segments of the same nerve are practically the same whether the union be effected in as nearly the old position as possible, or whether one end be partially rotated before suture (Kennedy). The results of nerve anastomosis and transplantation, both in the lower animals and in man, are still further proof that nerve impulses may be carried via new paths from the line of suture to its cutaneous or muscular termination. If, as the mass of clinical and experimental evidence would seem to indicate, transference of impulses with return of function is possible, the centers for these impulses in the central nervous system must be capable of altering their functions so that they may stimulate contraction in the new groups of muscles. I firmly believe with Kennedy that the return of function after nerve anastomosis is not to be attributed to a simple re-education process, but "is probably due to an alteration in the centers under the influence of altered afferent impulses from the muscles, the brain thus having the capacity quickly to adapt itself to such alteration." Re-education would take a considerable length of time and it has been proved that the return of co-ordinated movements after nerve crossing is no longer than after the suture of divided ends of the same nerve. If nerve centers are capable of thus altering their functions in accordance with the new afferent impulses, it would then seem that both nerve suture and anastomosis have a firm physiological foundation. In both cases there is transference of impulses to new paths.

Once the injured nerve is exposed, how shall we proceed? Shall we resect and suture? Shall we resect and implant? How shall we bridge the defect? If the continuity of the nerve be apparently intact, there may yet be loss of function, when fibrous tissue has taken the place of nerve-fiber and here inspection and faradic stimulation will be found helpful.

A rather novel suggestion in nerve surgery is that made by Hofmeister, who by injecting the nerve with a novocaine solution, identifies points of fibrous constrictions by the hourglass appearance of the nerve at the site of fibrous deposits. If there be any reason at all to believe that the continuity of impulses is not altogether destroyed better results will be obtained by releasing bands, by dissecting away cicatrices, by removing neuromatous enlargements, in other words, by neurolysis, than by any method of suture or transplantation. The experience of Hashimato in the Russo-Japanese war is preponderantly in favor of neurolysis as against suture.

If called upon to resect we must choose between lateral implantation, the use of the autotransplant, and the fascial or venous tube. The extraordinary facility with which adjacent nerves will assume the function of the injured after lateral implantation of the proximal and distal segments of an injured nerve was brought to my attention many years ago when in a case of aggravated spasticity of the upper extremity I effected a complete transference of the flexor into the extensor innervation only to find that after function was resumed by nerve union, the athetosis and spasticity returned with their original vigor. As between these three methods—lateral implantation, the use of the autotransplant, and tubulization—when the defect is not long, tubulization with the fascial cuff is the method of choice, using the technique Lewis employed so successfully in his experiments on nerve regeneration. But when the defect is more than two or three centimeters long better results will be obtained by lateral implantation. (Whether the intact nerve serves only as a bridge over which the new axis cylinders from the central and peripheral ends of divided nerves may pass, or whether the peripheral portions physiologically unite with the intact nerve whose fibers transmit their impulses is a question which can only be decided by most careful histological exam-

inations in a large group of experimental anastomoses.)

As to the minute details of nerve suture-all the difficulties and pitfalls will be expe, rienced in a course of apprenticeship in facio-hypoglossal anastomosis or facio-accessory anastomosis. Sharp dissection, rigid hæmostasis, the finest silk for suture material are of basic importance. Shall we surround the site of suture with fat or fascia or vein? It may not be necessary, but one or the other should be employed as a safeguard against the ingrowth of scar tissue—the great bugbear of nerve suture. We are told of the importance of accurate approximation, bundle for bundle, of a divided nerve, but to my mind all classical and theoretical considerations point to this refinement in technique as non-essential.

A discussion of peripheral nerve surgery at this date particularly in connection with the relief of paralysis, would be incomplete without reference to the so-called method of direct and muscular neurotization, the most original contribution for many a day. Erlacher has shown that the function of a paralyzed muscle may be restored by suturing a healthy nerve directly into the muscle, and, should there be no healthy nerve at hand, a flap of healthy muscle will suffice. The point of implantation into the muscle is not of vital importance, since histological studies show that new motor end plates form very soon after implantation, a principle applicable to paralysis of the anterior tibial muscle which may be innervated through the peroneus longus, to paralysis of the biceps which may be innervated by a flap from the triceps and to the paralysis of the deltoid which may be supplied by an implant from the trapezius.

Speaking of the management of individual palsies, I am reminded of some experiments carried out a few years ago in searching for a method of relieving deltoid palsy—the most frequent of the residual palsies of poliomyelitis, a rather timely topic. On the theory that each muscle is innervated by bundles of nerve fibers, which pursue their individuality unmixed in the parent nerve, I determined to ascertain whether it would not be possible to innervate the circumflex, which supplies the deltoid, with that portion of the musculo-spiral which supplies the triceps. Minute anatomical studies were made upon monkeys and human cadavers, both adult and infant, and it was found that the fibers supplying the triceps could be separated intact up to the edge of the tendon of the teres major ~~at which point~~ they occupied about one third of the dorsal portion of the nerve. This was a favorable site for anastomosis as the circumflex nerve was in close proximity.

The end-results on the monkey proved the operation to be entirely practical and wholly successful in that the deltoid, completely paralyzed by section of the circumflex, resumed its function after the distal end was united to the graft from the musculospiral nerve.

I have not applied the operation to the human, but I believe the principle ought not to be lost sight of and is worthy of your consideration.

Another method of dealing with spasticity still in the experimental stage is the implantation of surplus nerve fibers from the spastic muscle into the weakened antagonistic muscle; in other words, the application of "neurotization" to spasticity (Erlacher), whereby we attempt to strengthen the antagonistic muscle by supplying it with an excess of impulse from a center which is over irritable. While I firmly believe this method of transferring impulses has its field in the relief of paralyses, I am not in accord with its application for the relief of spasticity. In the latter we are dealing with a lesion, at some point in the corticospinal pathway, which has so injured the inhibitory fibers that they no longer efficiently control the sensory stimuli. Any procedure which does not interrupt the reflex arc at some point, thereby diminishing the sum total of the impulses, is unsound in principle and could not be followed by permanent results.

Dr. Porter has included in his discussion the treatment of brachial plexus palsies. There is no doubt that in most instances operation is too long delayed, and while this may account for many failures and is a painfully

long list of futile operations, I am convinced that the failures are not to be attributed alone to delay or to technical errors. It is more than likely that in many cases the degenerative processes extend to and involve the cells in the cord and in some instances the permanency of the paralysis is explained by the injury to the roots—anterior and posterior—within the dural sac. My attention was directed to the latter contingency by a case which came under my observation in 1910, a case upon which an exploratory laminectomy disclosed a rupture of both anterior and posterior roots.

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# RESECTION OF THE THYROID[1]

By EUGENE H. POOL, M.D., New York
Attending Surgeon, New York Hospital

PARTIAL thyroidectomy, as usually practiced, consists in extirpation of one lobe and isthmus, sometimes supplemented by resection of part of the second lobe. In the removal of the lobe the technique generally followed is an intracapsular extirpation, that is, the lobe is shelled out of the surgical capsule which is a connective-tissue envelop formed from the deep cervical fascia. It is universally recognized that extreme care must be exercised in the dissection at the posterior aspect of the lobe to avoid injury to the recurrent laryngeal nerve and to safeguard the parathyroid glands. To provide a greater degree of protection to these structures some surgeons have advocated leaving a layer of thyroid tissue in this region; but this procedure results in more hæmorrhage, which in some cases is difficult to control; moreover, it prolongs the operation and leads to greater postoperative exudate.

Fig. 1. Clamp for grasping thyroid prior to resection.

In a former article,[2] we presented the results of some investigations which were made to determine whether the theoretical advantages of leaving a portion of the posterior part of the lobe, that is, the part in relation with the recurrent laryngeal nerve and the parathyroid bodies, have sufficient anatomical basis to outweigh the practical disadvantages of the procedure. These studies, based upon 25 dissections, led to the following conclusions:

1. For the prevention of tetany the posterior part of one lateral lobe must always be left. But even when one lobe only is operated upon, permanent safety is best insured by leaving *in situ* the posterior part of

[2] Pool and Falk. Concerning the surgical anatomy of the thyroid with special reference to the parathyroid glands. Ann. Surg., Phila., 1916, lxii, 71.

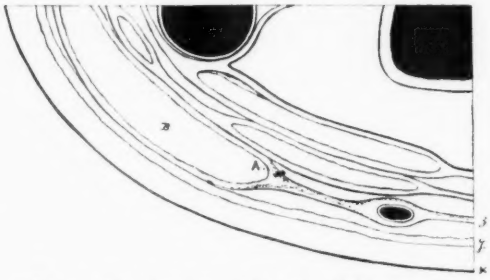


Fig. 2. The deep cervical fascia divides at anterior border of sternomastoid muscle *B*, into a deep and superficial layer. To raise flap containing skin *x*, platysma *y*, and deep cervical fascia *z*, the layer of this fascia which lies in relation with the deep surface of the sternomastoid muscle should be cut at *A* close to the division of the fascia into its two layers.

[1] Read before Surgical Section of the New York Academy of Medicine, October 6, 1916.

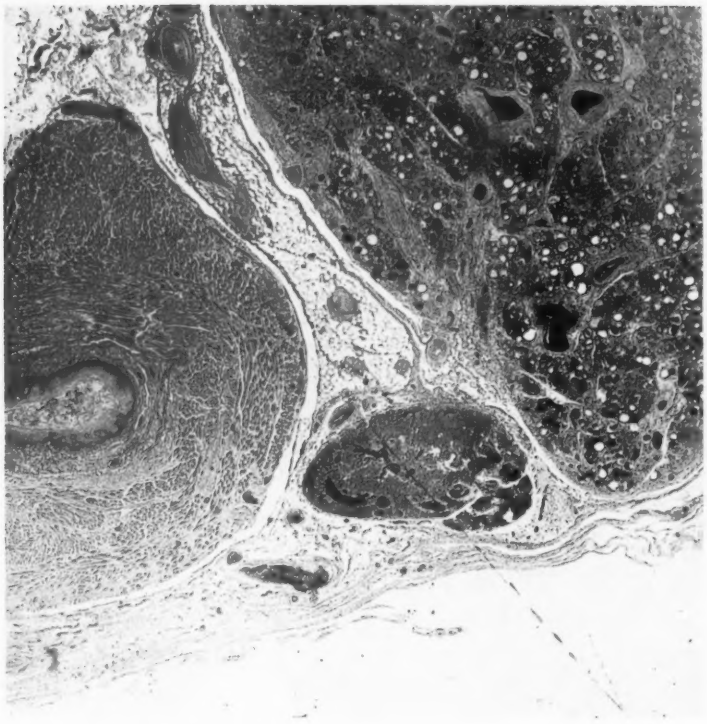

Fig. 3. Photomicrograph showing relative positions of parathyroid, recurrent laryngeal nerve, œsophagus, posterior part of lobe, and capsule. (Pool and Falk.)

that lobe. Then, if a subsequent operation with complete removal of the second lobe becomes necessary, the operation may be performed with relative safety.

2. The recurrent nerve is relatively immune from injury when a true intracapsular extirpation of a lobe is made. Yet, in attempting to carry out this procedure, the capsule may be torn quite easily at its posterior part and the cellular plane which contains the recurrent nerve may be entered in the dissection and the nerve injured (Fig. 3). This danger is avoided by leaving a portion of the posterior part of the lobe.

3. It is advantageous, although not imperative, to leave *in situ* the posterior parts of both lateral lobes in relation with each of which a recurrent laryngeal nerve and two parathyroids usually lie.

The amount of thyroid which must be left in a thyroidectomy to avoid myxœdema is variously estimated as from one-sixth to one-fourth of the gland. On the basis of what has been said it would seem advantageous to secure this thyroid sufficiency by leaving the posterior parts of both lateral lobes, resecting the anterior parts of both lobes together with the isthmus. Not only are the recurrent nerves and parathyroids thus safeguarded but, as Balfour[1] states: "All sense of pressure is relieved, and the neck is made quite symmetrical, which cannot be said of some of the cases in which an entire lobe has been removed and the opposite lobe left untouched. After such an operation one can assure the patient that there will be much less liability of recurrence of the goiter than with any other type of operation.

[1] Balfour. The advantages of double resection in certain types of goiter. Ann. Surg., Phila., 1914, lix, 671.

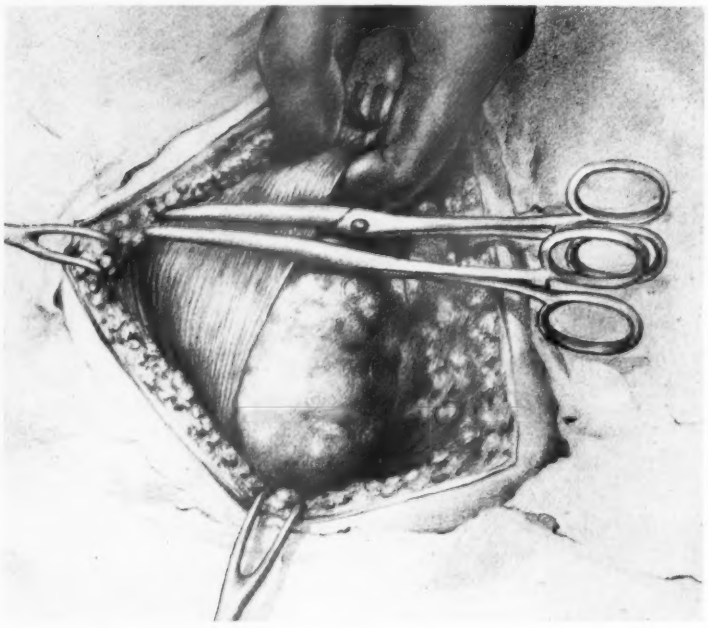

Fig. 4. Depressors of the hyoid separated in midline. Clamps applied high on right group prior to their division.

"The cases to which this operation is applicable are in general the diffuse colloid goiters. It is not necessary, of course, in the single cystic thyroid (or adenoma) where the trouble is due to an isolated tumor in the gland. It has a very limited field in the exophthalmic group where symmetry is a secondary consideration and the patient is operated on for relief of symptoms only."

In regard to the theoretical objections to resection it may be stated that hæmorrhage can be controlled and rendered slight either by Balfour's technique or by the use of such a clamp as is described in this paper. The duration of the operation is not materially increased, because in the resection it is not necessary that the lobe be stripped from within its capsule, therefore, the operation is facilitated by substituting a resection for an intracapsular extirpation. Finally, postoperative toxæmia need not, as a rule, be considered since the method is rarely employed in toxic cases, and then only in mild types.

Balfour describes the method of bilateral resection employed at the Mayo Clinic as follows: After freeing both lobes and planning what portions of each should be removed, the isthmus is divided and freed from the trachea. A series of artery clamps are placed on the larger vessels in the capsule. These forceps serve the joint purpose of marking the part to be resected and of enabling one to control hæmorrhage by traction on them along with support of the lobe from behind with the finger. The lobe is then encircled with an incision through the capsule just anterior to the forceps and the resection is then made by wedging out the anterior part of the gland. A continuous mattress suture of catgut is inserted behind the line of forceps. This controls bleeding and obliterates the cavity in the center of the lobe. The same suture, returning in an opposite direction, catches the edges of the capsule and rolls them together into some semblance to a normal lobe. The second lobe is treated in the same way.

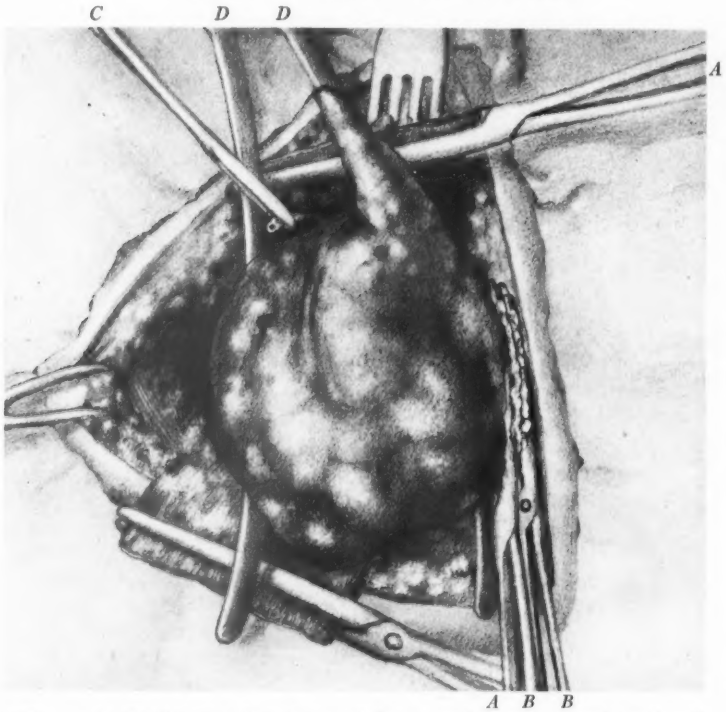


Fig. 5. Application of goiter clamp. Lobe exposed; superior vessels sectioned; pyramidal lobe freed; isthmus cut across. *AA*, clamp on sectioned depressor muscles; *BB*, clamps on divided isthmus; *C*, clamp on superior thyroid artery; *D*, goiter clamp.

The writer has found that in many cases the use of a clamp (Fig. 1), similar to a Scudder gastric clamp, facilitates the technique of resection by lifting and steadying the lobe and controlling hæmorrhage. The lobe is freed, with or without ligation and section of the superior vessels as the case demands; the isthmus is cut across and its stump separated from the trachea, the lobe is then grasped well back by the clamp which is placed vertically with one blade on each side of the lobe. The clamp has long delicate blades so as to lightly grip but not crush the thyroid; it has a broad clutch by means of which it may be locked while the blades are comparatively far apart as in grasping a broad lobe; the bayonet shape allows the blades to be introduced more readily into the wound. It is advantageous to have several clamps of different sizes. The following outline of the technique of bilateral resection is an elaboration of the description of an operation performed March 21, 1916; photographs were taken during the operation and from these the drawings were made.

*Bilateral resection for colloid goiter.*[1] Patient in oblique position with head on higher plane than feet. Sand bag under shoulders so as to extend the neck. Goiter frame with apron in place. Intratracheal anæsthesia with Janeway apparatus. Curved incision corresponding to natural crease of neck. Anterior jugular presented as one trunk; clamped, cut, and ligated. Deep fascia cut through to the infrahyoid and sternomastoid muscles. Flap of skin, platysma, and deep fascia freed with knife and lifted as far as the incisura of the thyroid cartilage. The

[1] For full description of technique see Johnson's *Operative Therapeusis*, vol. iii, p. 297.

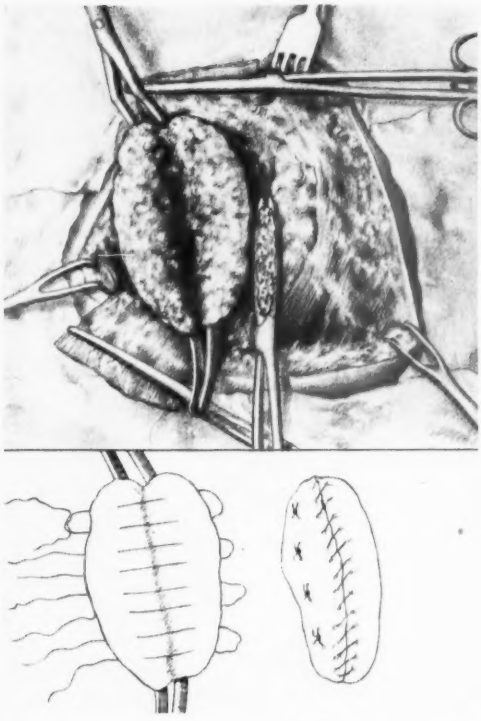

Fig. 6. *A* (above). Goiter clamp grasping resected lobe. Clamp on isthmus. *B* (lower left), Mattress sutures in place; *C*, lobe reconstructed.

separation of such a flap, including fascia and anterior jugular veins, is easy because of the natural cleavage plane between the muscles and the fascia. The feature to emphasize is that *at the anterior edge of the sternomastoid the division of the fascia which passes behind this muscle must be cut as the flap is lifted* (Fig. 2). The depressors of the hyoid now lie well exposed. They are separated vertically with scissors passed between the sternohyoid muscles. In general, for resection, especially in large colloid goiters, the sternohyoid, sternothyroid, and omohyoid should be cut across and reflected on one or both sides. The line of division of the muscles should be high so as to avoid their nerve supply. Two straight clamps of the Pean variety without teeth but with longitudinal serrations are placed transversely across the muscles which

Fig. 7. Diffuse colloid goiter before and after bilateral resection.

are to be severed (Fig. 4). The muscles are cut between the clamps which are left attached to the cut edges. This step may involve a confusing detail in that the sternothyroid is frequently extremely thin and, since its mesial margin is not visible, it may be left undivided after the sternohyoid and omohyoid have been cut and the operator, believing he has severed all these muscles, may be confused by the appearance of muscle fibers overlying the capsule of the gland. With care, all the muscles may be severed together. The handle of the lower clamp is slowly rotated and the muscles as a sheet are easily stripped free; the clamp is then allowed to hang over the outer edge of the wound. If the sternothyroid has not been divided together with the other muscles it should be clamped, cut, and reflected independently, otherwise this thin muscle layer interferes with the freeing of the lobe. The lobe with the large veins of the capsule now presents well exposed. By passing the finger gently into the plane mesial to the carotid, this tissue plane is opened up and the lobe is liberated from the surrounding tissues to a considerable extent. In the case under consideration the operation was continued as follows: The left index finger was introduced behind the upper pole, rendering the superior vessels accessible. These were ligated high. A clamp was placed across the vessels at the upper pole and the vessels were cut across. The lobe was then lifted forward and mesially and separated from the posterior tissues until the branches of the inferior thyroid artery were reached. The lobe was then allowed to drop back.

The pyramidal lobe was dissected free and two clamps were placed across the isthmus and the isthmus cut across between the clamps. The right portion of isthmus was freed from the trachea. The lobe, together with pyramidal lobe and stump of isthmus was then lifted and the goiter clamp placed from above downward and closed so as to grasp gently the posterior part of the lobe anterior to the recurrent nerve and parathyroid glands (Fig. 5). The lobe was thus steadied and sufficient pressure was exerted to control hæmorrhage. The large vessels on the surface were clamped just behind the proposed line of resection, and the anterior part of the lobe was excised by making two parallel incisions which converged in the center of the lobe near the plane of the goiter clamp (Fig. 6). The superficial vessels grasped by the artery forceps were then ligated. The goiter clamp was loosened sufficiently to recognize and clamp bleeders which were ligated. The two sides of the lobe were then approximated with mattress sutures and the edges overhanded with a continuous catgut stitch (Fig. 6, *A* and *B*). The goiter clamp was then removed. There was no bleeding. A small lobe was thus constructed without injury to the recurrent laryngeal nerve, the parathyroid glands, or the inferior thyroid artery before its entrance into the gland.

The left side was treated in the same manner. Two small lateral lobes were thus substituted for the enlarged thyroid. About one inch below the middle of the skin incision, a stab-wound was made and a small rubber tube penetrated by a piece of rubber tissue was introduced for drainage. The sand bag was then removed from beneath the shoulders so as to relax the muscles and the depressor muscles of the right side were approximated by a stitch which overhanded the two clamps grasping their cut edges. The clamps were removed and this stitch was drawn tight and tied. The muscles on the left were treated in a similar manner. Several interrupted catgut sutures were used to approximate the muscles in the midline. The deep fascia was closed with continuous chromic catgut and the skin with subcuticular chromic stitch.

A clamp to facilitate resection was first employed in a case of large diffuse bilateral colloid goiter illustrated in Fig. 7, operated upon at the French Hospital in November, 1908. Both lobes were resected. The case demonstrated the feasibility of cutting across a lobe at will and of leaving the posterior part of a lobe with its blood supply, thus ensuring a sufficiency of parathyroids with their blood supply and not endangering the recurrent nerve.

SUMMARY

1. In large diffuse simple goiters double resection is the procedure which most closely meets all indications. It relieves pressure, minimizes danger to parathyroids and recurrent laryngeal nerve, provides a sufficiency of thyroid tissue, and ensures symmetry.

2. Double resection may be carried out readily with little hæmorrhage either by Balfour's method or by the use of a clamp as described, or by a combination of the two methods.

# FATAL COMPLICATIONS OF PERCY'S "COLD IRON" METHOD IN THE TREATMENT OF INOPERABLE CARCINOMA OF THE CERVIX[1]

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AND
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IN 1912, J. F. Percy in a series of articles, advocated the application of long-continued low heat in the treatment of otherwise inoperable carcinoma of the uterus. This procedure is based upon a principle claimed by Percy, namely, that carcinoma cells are killed by low penetrating heat insufficient to destroy normal tissues. He introduces an electric heating iron into the uterus and maintains, for a considerable time, a temperature insufficient to char the tissues. The Percy method has been widely adopted and the results so far reported have been almost uniformly favorable. As far as has been ascertainable the only reported untoward results are a brief mention by Percy of infection and fistula formation, and the one instance of death from sepsis, reported by Boldt.

It is for this reason that the following cases, treated by this method in the Gynecological Clinic of the Johns Hopkins Hospital, with fatal results, are reported.

*Clinical history.*[2] L. D., a white woman, age 52, was admitted to the hospital April 24, 1916, complaining of pain in the lower abdomen and bleeding from the vagina. *Family history.* Was unimportant. *Personal history.* The patient always had enjoyed robust health. Menstruation began at 13 and continued regularly, without pain, until the

[2] A preliminary report of this case appeared in the J. Am. M. Ass., 1916, lxvi, 1549.

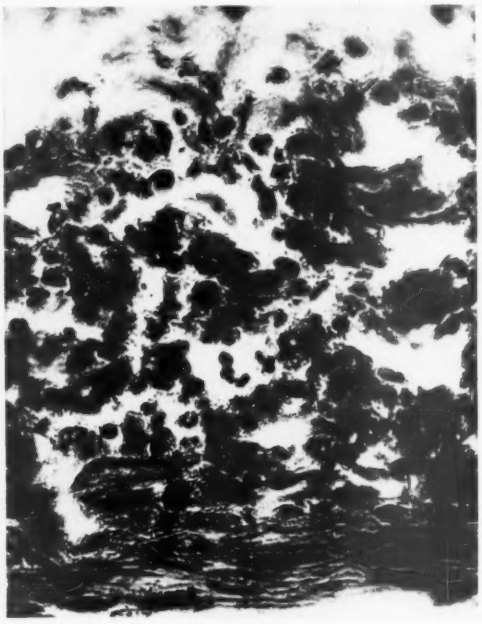

Fig. 1. Case 1. Base of gastric ulcer showing polymorphonuclear cells in the submucosa.

Fig. 2. Case 1. Carcinoma from the region posterior to the cervix, beyond the zone of coagulation.

[1] From the Gynecological Clinic and the Department of Pathology of the Johns Hopkins Hospital, Baltimore.

Fig. 3. Case 1. Edge of coagulation in the right broad ligament showing coagulated carcinoma below and the peritoneum and connective tissue above.

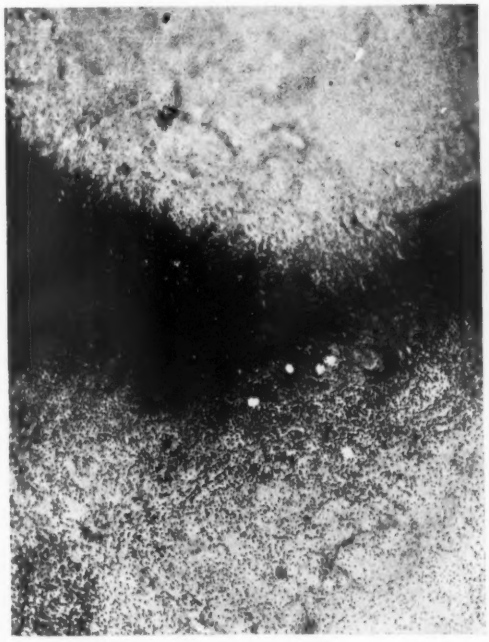

Fig. 4. Case 2. Edge of coagulation in the left broad ligament showing the blue staining zone separating the coagulated tissue below from the normal tissue above.

menopause at 42, ten years before her admission. She had been married 21 years and had had two children, both living and well. The labors were easy and the puerperia uneventful.

*Present illness.* Six months before her admission to the hospital there was a profuse vaginal discharge of clotted blood lasting several days, which recurred once several weeks later. Otherwise there was no history of bleeding obtainable.

Three months before admission the patient noted rapid loss of weight; felt "run down" and had no appetite. Shortly afterward she began to have dragging pains in the lower abdomen which became progressively more severe but never excessive. Burning on micturition, constipation and painful defæcation were the only other symptoms.

*General physical examination.* Was negative except for moderate tenderness to deep pressure over the lower abdomen. *Pelvic examination.* The vaginal outlet was moderately relaxed. The vaginal portion of the cervix was entirely destroyed by a rough, firm growth. The lateral fornices were resistant and sensitive. The fundus was small and in anterior position. Its mobility was greatly restricted. *Rectal examination.* There was a firm mass in each broad ligament; that on the right was somewhat the larger and adherent to the pelvic wall.

The white blood count, 19,240; hæmoglobin, 56 per cent (Sahli).

*Clinical diagnosis.* Carcinoma of the cervix, inoperable.

*Operation.* The abdomen was opened in the midline and the intestines packed off from the pelvis. There was a mass 3 x 6 centimeters in the right broad ligament continuous with the uterus and a hydro-ureter on this side measuring 1.5 centimeters in diameter. A somewhat smaller mass occupied the left broad ligament. The right adnexa were atrophic but otherwise normal. The left tube was swollen and its fimbriated extremity closed and adherent to the sigmoid. The lumbar and iliac glands were not enlarged.

The left tube was removed. Both internal iliac arteries were ligated with silk. The peritoneum was closed over the ureter and vessels on each side of the pelvis and then both infundibulopelvic ligaments ligated.

Then the patient was placed in the perineal position and the vagina dilated manually until it readily admitted the water-cooled speculum. A piece of tissue was removed for section. A Percy

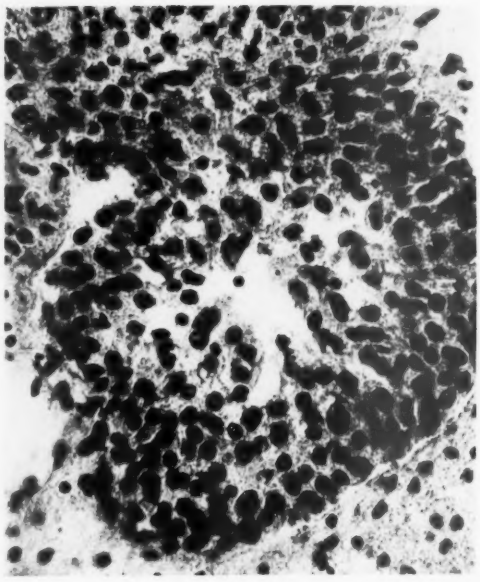

Fig. 5. Case 2. Carcinoma-cells in the left broad ligament beyond the zone of coagulation.

cautery (Point A) was then introduced into the uterine cavity and heating continued one hour at a temperature low enough to avoid charring the tissue and low enough to prevent excessive discomfort to the assistant, whose gloved (medium weight rubber) hand in the abdomen held the uterus continuously. The temperature, however, was high enough to bring occasional warnings from the assistant, and to cause the heating point of the cautery to become firmly fixed in the uterus. It became necessary several times on warning from the assistant to twist the point out of the uterus. In each instance a thick shell of coagulated tissue was found firmly adherent to the point and this was scraped off before its reintroduction. At the end of one hour the uterus had not become movable.

Percy cautery (Point E) was then introduced for one-half hour into the middle of the mass in each broad ligament. The uterus then became quite movable.

The sigmoid was placed over the pelvic viscera, the omentum properly disposed and the incision closed in the usual manner.

*Postoperative course.* The patient was returned to the ward slightly shocked. Pulse 130, of rather low tension, and somewhat irregular. Respirations 36. Fifteen hundred cubic centimeters of salt solution were introduced under the breast, with general improvement toward evening.

On the second and third days the upper abdomen was distended, the patient vomited large quantities of brown watery fluid and there was an involuntary loss of urine. The temperature never went above 100°. The pulse varied between 100 and 140. The respirations varied between 22 and 40. The condition gradually became worse and on the fourth day the abdominal distention became general. Enemata were ineffectual and the vomiting continued. Before preparations for enterostomy could be completed the patient suddenly died with symptoms suggesting pulmonary embolism.

*Autopsy* No. 4674 (17 hours after death).

The protocol will be briefly abstracted and only those findings which seem of particular significance will be reported in detail. The body is that of a well-nourished white female, 152 centimeters in length. There is no superficial glandular enlargement. The abdomen is distended. A clean midline incision is held together by sutures.

The peritoneal cavity contains about 100 cubic centimeters of serosanguineous fluid which contains some flecks of fibrin. The large and small intestines are distended down to the sigmoid which is collapsed. They are glued together in places by a little fibrinous exudate. The liver is pushed up by the distended intestines, otherwise the abdominal viscera are normally disposed. The abdominal lymph-glands are in no instances enlarged.

Both pleural cavities contain about 500 cubic centimeters each of a clear blood-tinged fluid. The pleural surfaces are everywhere smooth and glistening.

The pericardial cavity contains 15 cubic centimeters of clear yellow fluid and is otherwise normal.

*Heart* weighs 240 grams. It is soft and flabby, but shows no gross lesion. The *lungs* are congested. This is most marked in the dependant portion. They are crepitant throughout. In one of the main branches of the right pulmonary artery is an embolus in the form of a long thrombus coiled several times upon itself. The smaller branches are nearly all thrombosed, as are also those of the left lung. *Spleen* weighs 95 grams. It is firm. On section the connective tissue is conspicuous.

*Stomach and duodenum* are distended with gas. There are about 24 round ulcers from 1 to 7 millimeters in diameter scattered over the mucous surface of the stomach but more numerous at the pyloric end. They have clean bases and edges which are not elevated. The loss of substance apparently extends to the muscularis. The peritoneal surface shows nothing abnormal. The mucosa aside from the ulcers is smooth and pale. The duodenal mucosa is intact.

The *pancreas* weighs 105 grams. Grossly and on section it is normal. The *liver* weighs 185 grams. It is very soft and does not maintain its shape. Its color is light yellowish brown. On section the soft parenchyma seems under tension and causes the cut edges to evert. The structure is obliterated and the surface presents only a uniform yellow color. The *adrenals* are very soft and crumble when attempts to dissect them are made.

The medulla has softened into a thick chocolate-like fluid.

*Kidneys.* Right weighs 160 grams. The capsule strips readily, leaving a smooth gray opaque surface. The striations are well seen and are regular. The glomeruli appear as glistening dots. The cortex measures 4 to 5 centimeters. The pyramids are dark red.

Left kidney weighs 145 grams and is similar to the right. *Pelvic organs* are removed in one mass. The rectum and sigmoid show no gross abnormalities. No anatomical obstruction can be found. They are removed readily from the remaining pelvic organs. Externally the uterus is normal in size and contour. The peritoneum over the bases of the broad ligaments is discolored a purplish red. The vesico-vaginal space is obliterated and the posterior wall of the bladder is closely adherent to the vagina. The ureters show nothing abnormal down to their entrance into the broad ligament.

The mucous membrane of the bladder is injected except in the trigone where there is a fistula measuring 2 x 3 centimeters opening into the vagina. The edges of the fistula are reddish black and necrotic in appearance. A probe passed through the proximal end of the left ureter emerges in the wall of the fistula; passed through the right ureter it ends in a necrotic mass about 3 centimeters from the wall of the bladder.

In the vagina the orifice of the fistula is similar to that described in the bladder. The cervix and the tissues directly surrounding it are destroyed. The tissues in the neighborhood are no longer recognizable. They have a foul odor, a grayish white color, and a putty-like consistency. On section this necrotic mass ends abruptly about 1 centimeter from the necrotic surface. Beyond this a gritty material of cartilaginous consistency occurs here and there in the bases of the broad ligaments.

The *neck organs, aorta and brain* show no abnormality. The *intestines* are intact with no anatomical obstruction.

In the microscopic examination of all the viscera the following abnormalities were noted.

*Lungs.* The alveoli contain a few red blood-cells particularly noticeable in sections from the posterior portions.

*Stomach.* The gastric mucosa is well preserved. As an ulcer is approached the definition of the cells of the mucosa become obscured and the nuclei are unstained by hæmatoxylin. The ulcer consists of a loss of substance extending through the submucosa to the muscularis. At the inner edge of the muscularis there is a distinct line of polymorphonuclear cells across the base of the ulcer (Fig. 1). A large blood-vessel in the immediate neighborhood of the ulcer is intact. *Liver.* In the central part of the lobule the cells show fatty change. Elsewhere they have undergone extreme swelling and disintegration. *Adrenals.* Cortex is apparently normal. In the medulla there is a general disintegration of the tissue. *Kidneys.* The general structure is normal. There is extensive epithelial necrosis in the convoluted tubules. *Lymph-glands.* The lymph-glands are normal. They do not show necrosis or metastases.

*Pelvic organs.* Sections from both broad ligaments and from the posterior wall of the vaginal vault at the level of the cervix show perfectly preserved squamous-cell carcinoma. Sections from the necrotic areas stain a uniform bluish pink and carcinoma tissue can be distinguished only by its outline. All gradations can be seen between this necrotic area and the surrounding well-preserved tissue (Fig. 3). In these intermediate areas many of the nuclei of the cells are unstained and show karyolysis or karyorrhexis. Other cells intermingled in these areas have bright pink staining cytoplasm and a sharp well-stained nucleus. In many cases mitoses are seen. The changes observed in the connective tissue and smooth muscle of the pelvis are analogous to those in the neoplastic tissue. The nuclei become obscured and broken up and the tissue stains uniformly bluish pink. The vessels are all thrombosed. Masses of polymorphonuclear cells occur throughout the tissues as well as large blue staining, amorphous masses of bacteria. There are several areas where carcinoma-cells are invading normal tissue. In these there is nothing to indicate any difference in susceptibility between the carcinoma and normal tissue. The cytological changes are in every instance equidistant from the necrotic edge. In making blocks care was taken to cut them in a plane radial to the necrotic edge to make the observations certain. In a block taken posteriorly from the cervical region the zone of cytological change had a maximum width of 6 millimeters (Fig. 2).

*Anatomical diagnosis.* Primary carcinoma of the cervix of the uterus (operation, laparotomy and cauterization); vesicovaginal fistula; intestinal distention; thrombosis of pelvic veins; hydrothorax (bilateral); multiple gastric ulcers; epithelial necrosis of kidneys; cloudy swelling of viscera. *Subsidiary* chronic mitral endocarditis; fatty liver; encapsulated caseous tuberculous bronchial lymphadenitis.

The pathological changes in this case, pulmonary œdema, hæmorrhagic serous effusions, extreme cloudy swelling of the viscera, renal epithelial necrosis, and gastric ulcers correspond to the findings in extensive superficial burns. It is therefore possible that death may, in part, be due to the same unknown factors. On the other hand, the pulmonary embolism was important.

CASE 2. *Clinical history.* I. P., a white woman, age 55 years, was admitted to the hospital for the first time in October, 1915, complaining of a bloody vaginal discharge. *Family history* was unimportant. *Present history.* After a normal menstrual life the

menopause set in at the age of 45, ten years before her admission. She had been married 40 years and had had nine children. The labors and puerperia were uneventful.

*Present illness.* Three months before admission she began to have a persistent bloody vaginal discharge, and two months later two profuse hæmorrhages. She had lost 10 pounds during this period.

*General physical examination* was negative. *Pelvic examination.* The perineum was moderately relaxed. On the posterior lip of the cervix there was a small, friable granular area not more than 2 centimeters in its greatest diameter.

The lateral fornices were soft and there were no pelvic masses. No tenderness was made out.

*Clinical diagnosis.* Carcinoma of the cervix, early.

*Operations.* The uterus was removed with a wide margin of parametrium on both sides (Wertheim).

*Pathological report.* Squamous-cell carcinoma of the cervix. The convalescence was uneventful save for a cystitis which developed after repeated catheterization.

*Subsequent history.* Four months after leaving the hospital the patient had pain in the lower left abdominal quadrant and frequent painful micturition. One month later there was a slight blood-tinged vaginal discharge. This had continued four days when she was readmitted to the hospital, April 26, 1916. She had lost ten pounds since leaving the hospital. *General physical examination.* There was marked tenderness to moderate pressure over the left abdominal quadrant. *Pelvic examination.* The left broad ligament contained a firm sensitive mass measuring about 5 centimeters in diameter which was firmly adherent to the pelvic wall.

*Clinical diagnosis.* Recurrent carcinoma, left broad ligament.

*Operation.* The abdomen was opened in the midline, the scar of the previous operation being resected, and the intestines packed off from the pelvis. There were no adhesions, the pelvic peritoneum being everywhere smooth. No involvement of the regional lymph-glands could be determined by palpation. The ovarian vessels had been ligated at the previous operation. Both internal iliac arteries were now ligated with heavy silk and the slit in the peritoneum closed on each side of the pelvis. The incision was protected, the patient placed in the perineal position and the vagina dilated to admit the whole hand. A Percy cautery (Point E) was then introduced through the water-cooled speculum into the middle of the left broad ligament mass. The tip of the point came within 1 centimeter of the serous surface. Heating was continued for two hours at a temperature just insufficient to char the tissue.[1]

[1] In this case the operator's right hand introduced into the abdomen grasped the broad ligament mass; the left hand controlled the cautery. At the conclusion of the operation an assistant, freshly gloved and gowned, closed the abdomen. Dr. Boldt has advocated this modification of the technique. Am. J. Obst., N. Y., 1916, Jan., p. 1.

During the entire process a constant sizzling sound could be heard, and occasionally a little oily fluid would run down from the heated area into the vagina. The broad ligament mass became adherent to the cautery point, and on two or three occasions the surface temperature was raised to a point which could not be borne by the hand encased in a medium weight rubber glove. On these occasions the assistant twisted the point out of its bed, removed the shell of coagulated tissue, and immediately reintroduced it.

At the conclusion of the operation the patient was in excellent condition. The pulse had varied from 100 to 120 throughout.

*Post-operative course.* The patient's condition for four days was excellent. On the fifth day urinary incontinence developed. Her temperature had varied between the extremes of 99° and 102.5° when, on the tenth day, it rose to 105° and from then on remained irregularly elevated, reaching a maximum of 108°. Blood cultures on the twelfth and fourteenth days showed respectively 10 and 150 colonies of streptococcus per cubic centimeter. Death occurred on the sixteenth day.

*Autopsy* No. 4687 (six hours after death). The following points were noted: The body is that of a poorly nourished white woman 157 centimeters in length. A recent mid-line scar, in perfect condition, runs from the umbilicus to the pubis. There are a few delicate fibrinous adhesions in the pelvis and there is a little pocket posterior to the left broad ligament containing 3 to 4 cubic centimeters of green pus. The left pleural cavity is normal. The right pleural cavity contains 500 cubic centimeters of clear yellow fluid containing flecks of fibrin. A little fibrin can be seen on the surfaces. The pericardial cavity contains 50 cubic centimeters of cloudy yellow fluid. Smears show many polymorphonuclear leucocytes and long chains of streptococci. There are many extensive subserous ecchymoses in the pericardium.

*Heart.* Weighs 300 grams. It is normal. *Lungs.* Beside a little hypostatic congestion and a fibrous scar at the apex there is nothing noteworthy. *Spleen* weighs 70 grams. It is normal. *Stomach and duodenum* are normal. *Pancreas* weighs 80 grams. It is normal. *Liver* weighs 1670 grams. Aside from a slight cloudy swelling it is normal. *Adrenals* are normal. *Kidneys.* Right weighs 130 grams, left weights 140 grams. They are normal.

*Pelvic organs.* Are removed in one mass.

The rectum and sigmoid show no gross abnormality and are readily removed from the remaining organs. The peritoneum over the vaginal vault has closed perfectly following the first operation. It is injected and there is a slight fibrinous exudate. The vesicovaginal space is obliterated and the bladder is closely adherent to the vagina. The ureters are normal up to their entrance into the broad ligament. The mucous membrane of the bladder is injected. In the trigone there is a fistula less than

1 centimeter in diameter which communicates with the vagina. The edges are black and necrotic. A probe passed down the right ureter emerges at the edge of the fistula; passed down the left ureter, it ends in a necrotic mass about 2 centimeters from the wall of the bladder.

In the vagina the edges of the fistula are much more discolored than in the bladder. The vaginal vault is intact, but extending out into the base of the left broad ligament is a soft, gray necrotic mass of tissue with a central opening representing the position of the coagulating point. Within 1 centimeter of this lumen, the necrotic tissue ends abruptly in normal-looking fat and connective tissue.

*Microscopically*, the viscera show no particular change.

The pelvic tissues are very œdematous and polymorphonuclear cells are prevalent everywhere. The smaller blood-vessels are thrombosed. Extending from the area of necrosis there is a zone, with a maximum width of not over 6 millimeters in any section, where the tissue is uniformly pink-staining except for blue amorphous masses of bacteria. The tissue structure in this area has entirely disappeared. Separating this zone of coagulation from the more remote tissue is a zone about 1 millimeter in width which stains a deep blue and under high power is seen to consist of granular nuclear material and polymorphonuclear cells (Fig. 4). Carcinoma-cells can only be found in the left broad ligament near the bladder sinus. They are situated in clumps just beyond the zone of coagulation (Fig. 5).

*Anatomical diagnosis.* Primary — operation: previous panhysterectomy for carcinoma of the cervix, recent ineffectual Percy cauterization of recurrence in the left broad ligament; streptococcus septicæmia; purulent pericarditis; fibrinopurulent pleurisy (left). Subsidiary — pulmonary congestion. Encapsulated apical pulmonary tuberculosis.

## SUMMARY

The primary effect of the Percy cautery is to cause a necrotic mass extending more or less uniformly in all directions from the coagulating point.

A mass of sloughing coagulated tissue of this type offers an ideal medium for the growth of micro-organisms. This is borne out by the sections of these two cases. It probably will be found impossible to prevent infection of this area, and once infected the thrombosed vessels of the region may offer a ready entrance into the system. Therefore the danger of a septicæmia is considerable.

We are convinced, from our short experience with Dr. Percy's method, that fatalities must have been frequent wherever this method has been used extensively, yet we have been able to find only one complete report of a fatal case in the literature, that of Dr. Boldt. This case is of particular interest to us because it agrees in all essential points with the findings in Case 2, and emphasizes the probable frequency of the development of a septicæmia from the infected tissue at the coagulated area. In an article in *The Pennsylvania Medical Journal* (January, 1916), Dr. Percy mentions four cases in which "post-mortem examination disclosed more or less of these lytic cells in a pultaceous mass, free in the pelvis. In one case, there was easily a pint of this material." The description of the clinical picture of these cases agrees fairly well with that of a fatal septicæmia, and it seems possible to suppose, since blood-cultures, microscopical examination, or cultures of the mass were not reported, that the four cases may have died of sepsis.

In Dr. Boldt's case and in the two cases reported above, the Percy technique was applied most rigidly. Nevertheless, microscopic sections show active uninjured carcinoma respectively four, eight, and sixteen days afterward. In both of our cases it was found within one centimeter of the previous site of the heating iron.

## CONCLUSIONS

1. The prolonged treatment of large carcinomatous masses by low heat may result in a rapidly fatal outcome with lesions similar to those in cases of fatal cutaneous burns.

2. The necrotic mass produced by the cautery forms a particularly favorable medium for bacterial growth. The organisms may spread to the surrounding tissues or reach the general circulation through the local thrombosed vessels. It seems probable that the greatest danger in the application of the Percy cautery is a local infection and a subsequent general sepsis.

3. Finally, the technique is ineffectual in eradicating the carcinoma. There is no evidence from these two cases that carcinoma is more susceptible to heat than is normal tissue.

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# TECHNIQUE OF TRANSVESICAL PROSTATECTOMY

## Details of the Two-Stage Operation[1]

By PAUL M. PILCHER, M.D., F.A.C.S., Brooklyn

TRANSVESICAL prostatectomy has been in use for many years with varying degrees of success. Its universal acceptance as the method of choice for prostatic enucleation has been delayed by several unpleasant, and often dangerous, features which have resulted from imperfect technique. Chief among these factors have been —

1. The discomfort to the patient due to continuous urinary leakage from the suprapubic wound.
2. The sloughing and infection of the wound.
3. Incomplete control of hæmorrhage.
4. Confinement in bed.
5. Prolonged urinary leakage and a foul wound.
6. Long-continued urinary fistula.

The technique which has been developed for the elimination of the disagreeable features and the control of the dangers accompanying the operation, have gradually shaped themselves into a logical sequence, and a more or less definite method which results in a far greater degree of safety and comfort to the patient, and in the great majority of cases has made the removal of the prostate a comparatively safe and easy operation.

The special features which recommend this method are:

1. *Renal decompression with the least risk.* This is the first and most important requirement in these cases. It may be accomplished in one of two ways, either by the repeated or continuous use of the catheter or by suprapubic cystostomy; in other words, by relieving the urinary stasis. We prefer suprapubic cystostomy performed under local anæsthesia.[2]

2. *Complete urinary drainage* by means of a suprapubic tube *without urinary leakage*, and without injury or irritation of the urethra. The technique about to be described, provides a means of avoiding the constant urinary leakage which has prevented many surgeons from adopting the two-stage operation. The bladder is completely drained or left partly full as the special features of the case may demand. The patient is allowed *out of bed within 24 hours* after the cystostomy.

3. *The securing of primary union of the cystostomy wound*, thereby establishing an avenue of approach to the prostate, protected by walls of granulation tissue; and excluding the tissues and spaces most easily infected in opening an infected bladder. The prevesical and perivesical spaces are sealed up and are no longer features of the operation. This result is obtained in fully 95 per cent of the cases operated upon by this technique.

4. *Full recovery from the stage of depression* following renal decompression. This can be accurately measured, not only by means of chemical tests but is judged as well by the ordinary standards of the clinician. (See Chart.)

The primary surgical indication has been met, i.e., the relief of the urinary stasis, and we can wait for weeks or even months if necessary before removing the prostate.

5. *Transvesical enucleation of the prostate* without reopening the prevesical and perivesical tissues. It allows a rapid enucleation of the prostate *with the minimum of anæsthesia.*

6. An *absolute means of controlling the hæmorrhage* following prostatectomy. The use of a specially constructed bag brings direct pressure to bear on the bleeding surfaces and effectively closes the vessels.

7. Simple means of *keeping the patient dry*, using a button drainage tube (Figs. 24 and 25), providing complete urinary drainage without urinary leakage, making superfluous all the cumbersome apparatus formerly used, i.e., vacuum drainage attached to house water supply, siphon drainage (Bremmerman), Dawbarn's drainage, etc.

[2] Pilcher. Ann. Surg., Phila., 1914, April.

[1] Read in part before the New York Urological Society, March, 1916.

8. *Shortening the period of confinement in bed.* Following both the first and second stage the patient is allowed out of bed within 24 to 48 hours after the operation.

9. *Systematic education of the bladder* to resume its function early.

### TECHNIQUE OF THE FIRST STAGE

We perform a suprapubic cystostomy as a preliminary operation in every case of prostatic hypertrophy due to simple glandular hyperplasia, even when we have previously used an indwelling catheter. In cases where there exists an enormous dilatation of the bladder especially where this is accompanied by œdema of the legs, scrotum, or penis, we practice gradual withdrawal of the urine through an indwelling catheter before performing the cystostomy. The main object of our first stage is to obtain a gradual diminution of the back urinary pressure which has disorganized the physiology of the kidney. In all other cases we proceed immediately to the suprapubic cystostomy.

*Suprapubic cystostomy.* The operation is attempted *under local anæsthesia.* The preparation consists of the usual catharsis given 48 hours previous to the time of the operation; no cathartics or enemata within 24 hours of the operation. Preparation of the field of operation by shaving and cleansing with soap and water the day before operation, and the application of iodine when the patient is ready for operation. In emergency cases the area is shaved, Harrington's solution is applied followed by washing with alcohol.

Everything possible is done to compose the mind of the patient and inspire confidence in the operator. Examinations are carried out with utmost care and gentleness. As few as possible are made. At night the patient is given twenty to thirty grains of sodium bromide, and this is repeated in the morning. In many cases we administer morphine sulphate $\frac{1}{4}$ grain and atropin $\frac{1}{150}$ grain, half an hour before the operation. Urotropin and sodium benzoate may be given if desired, but they are not necessary. Many urologists object to the use of morphine in these cases, but the writer feels that each case is a law unto itself and the operator must judge the individual and not work by rule of thumb.

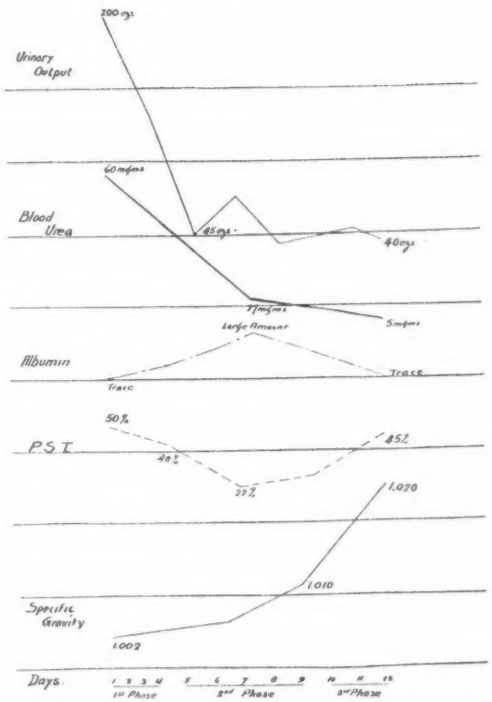



Chart of a patient treated at the Pilcher Clinic showing the reaction following first stage of operation. Showing the three phases of renal adjustment and gradual recovery from stage of depression. The amount passed in 24 hours dropped from 200 to 45 ounces. Gradual drop in blood urea from 60 to 5 milligrams; marked change in albumin content; drop and secondary recovery in the phthalein output; very marked improvement in the specific gravity of urine. The convergence of all lines in comparing the condition on entrance to the clinic and at the end of third phase is quite apparent.

*The ideal technique* — a painless, shockless operation; clean cut division of the tissues; a good exposure of the anterior surface of the bladder with the least possible disturbance of the perivesical structures; protection and reflection of the peritoneal fold; fixation of the bladder-wall before opening the same; placing the opening and fixing the button drainage tube in the very summit of the bladder close to the peritoneum and as far away from the urethral opening as possible; introducing the drainage tube with little if any soiling of the wound; making a water-tight

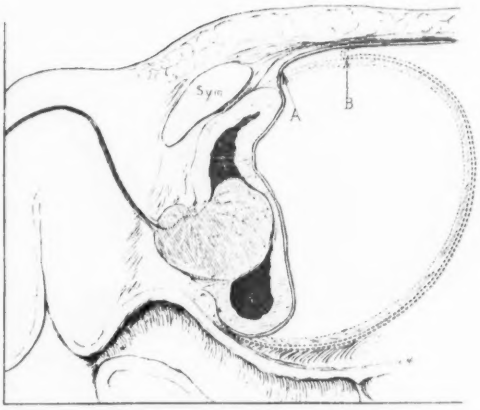



Fig. 1. Showing the surgical problem. Special attention should be directed to *A*, the fold of peritoneum in its relation to the symphysis when the bladder is contracted; *B* the raising up of the peritoneal fold when the bladder is dilated. The relation of *A* and *B* to the symphysis is quite variable and in some is fixed almost at the symphysis.

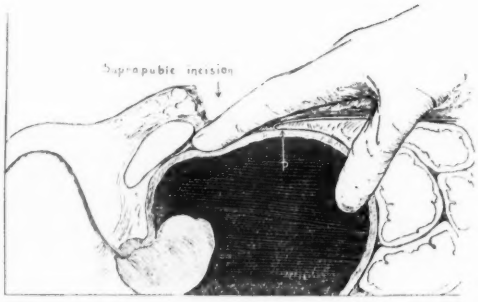



Fig. 2. First step in reflexion of the peritoneum Index finger inserted in wound to under surface of symphysis then forced downward to anterior wall of the bladder and sweeping backward carries the peritoneal reflexion with it. *P* peritoneal reflexion.

bladder — drainage-tube joint; careful resuture of the wound, closing all dead spaces; careful application of the dressings, supporting the wound. The details must vary with the individual case. The shockless, painless operation can be secured in the majority of cases by following out the principles of anoci-association. Novocaine 1/5 of 1 per cent is used to infiltrate the skin and deeper tissues, as well as the bladder-wall. This in turn is fortified by the injection of 1/4 per cent quinine and urea hydrochloride into the muscles, perivesicular tissues, and next to the peritoneum.

The skin incision is begun one inch above the symphysis and continued in a vertical direction toward the umbilicus for about four inches. The fat and fascia are divided with a knife and the recti muscles are separated by the finger; the remaining fascia and prevesical tissues are easily separated. At this point the bladder is well filled with sterile water through a catheter introduced by way of the urethra, after thoroughly cleansing the bladder. If it is not possible to introduce a catheter without undue force, it is not attempted.

With the bladder full, the finger is introduced into the wound until the under surface of the symphysis pubis is reached; then the finger covered with gauze is slowly swept upward gradually cleaning the tissues away from the anterior surface of the bladder, at the same time forcing the peritoneal fold ahead of it. This is of great importance because the peritoneal fold frequently extends so low that it lies over the anterior wall of the bladder (Figs. 1, 2, and 3). After the bladder-wall has been cleared it will be recognized by the tortuous dilated veins presenting on its surface, extending somewhat in a fan shape upward. Also the appearance of the thickened muscle bundles forming the bladder-wall is characteristic. When the finger is removed the peritoneal fold will be seen to sag downward. Great care must be exercised in pushing back the peritoneum for it is easily torn. This accident has occurred to the writer, but no untoward symptoms have followed the repair of this injury.

When the bladder-wall is properly bared, retractors are introduced, two lateral ones to hold back the muscles, and one in the upper angle of the wound to hold back the peritoneal fold. When all is in readiness, two retaining sutures are introduced into the bladder-wall (Fig. 5), about an inch apart on either side of the point where the bladder is to be incised. This point is chosen at the uppermost limit of the bladder, near the peritoneal fold (Fig. 4). Before the bladder is opened the fluid is allowed to flow out through the urethral catheter. The button drainage tube

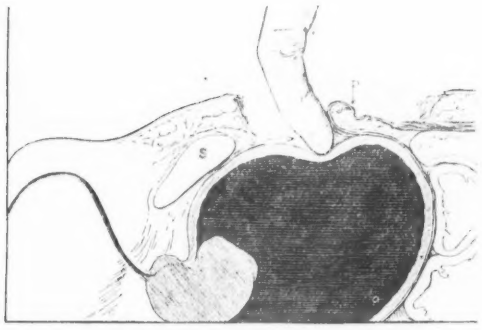


Fig. 3. Second step in freeing anterior wall of the bladder preparing same for high incision. Finger has been swept back from symphysis along anterior face of the bladder carrying with it peritoneal fold *P*. If finger is removed from the wound at this point, the peritoneal reflexion will be seen forcing its way downward with each respiration of the patient.

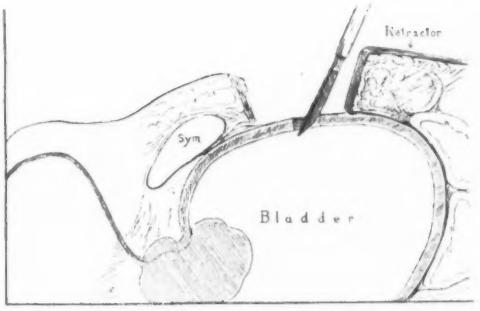



Fig. 4. Showing the position of incision into the bladder preferably at a point three inches from the urethral opening. The peritoneal fold has been reflected high up. The incision should be placed as high as possible.

is chosen (Figs. 24 and 25) and is held ready for use. Then the bladder is held up and steadied by the stays or clamps if preferred and an opening is made at the point chosen. The finger is inserted through the opening (Fig. 5), the interior of the bladder explored, foreign bodies, calculi, etc., are removed and the character and size of the prostate is determined. When the finger is withdrawn the button drainage tube is immediately inserted and fixed in place either by a purse-string suture of chromic gut or silk or by tying the stay sutures around the tube. If it is undesirable to empty the bladder the tube is plugged with a cork; otherwise the tube is allowed to drain as it will. At times small vessels in the bladder-wall are injured. These should be searched for and controlled.

*The drainage opening.* One should be perfectly satisfied with the position of the new opening in the bladder before completing this step of the operation. If after exploring the bladder the opening is found to be in the lower half of the bladder, which would bring it too near the urethral opening, it is better to re-introduce the finger in order to better outline the upper limits of the bladder (Fig. 7), and with this as a guide, slowly dissect back the peritoneum and make a new opening higher up (Figs. 7 and 8). Then the first opening should be closed with a double layer of chromic gut (Fig. 9). In this way we can almost positively assure ourselves of a rapid closure of the suprapubic wound provided that all of the obstructing prostate be removed.

Being satisfied with the fixation of the tube and its position, and after testing it to see that it drains and runs free, the prevesical space is next closed by catgut suture, obliterating all dead space between the symphysis, the fascia, and the bladder-wall. Then the fascia and muscles are brought together below the tube (Fig. 10) by interrupted chromic gut sutures leaving the tube high up in the wound. The fascia and muscles protecting the peritoneum are likewise sutured with interrupted chromic gut sutures, leaving only a little space not closed around the tube (Fig. 10). Then the skin is brought together by interrupted silk sutures (Fig. 10). The drainage tube should be further steadied by fixing it to the skin by means of an adhesive strip (Fig. 28). Then dry gauze dressings are applied and held in place by strips of adhesive tape.

The urethral catheter should be removed.

If, during the course of the operation, the local anæsthesia is not sufficient to deaden the pain of the operation, a general anæsthetic should be given. The writer never uses spinal anæsthesia in these cases. Some operators, however, prefer it. The indications for its use are similar to those for other operations on the same subjects.

*The convalescent period.* Following the application of the dressings the patient is

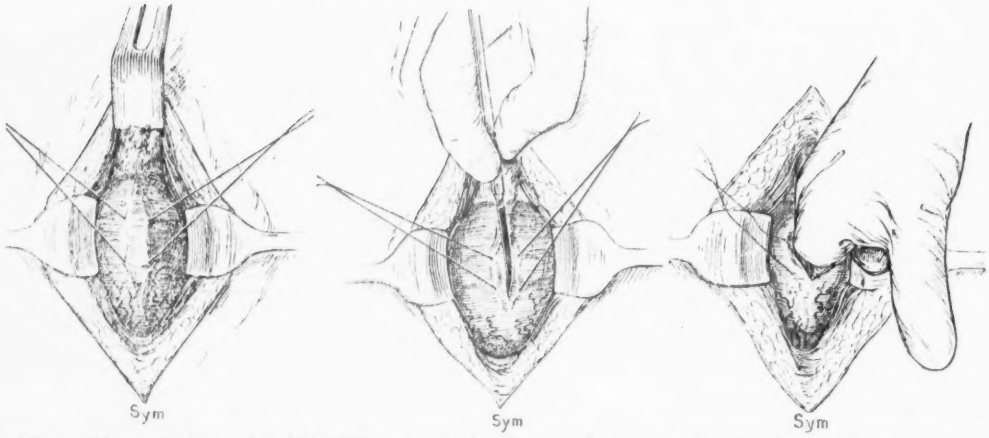



Fig. 5. Three steps in opening the bladder. (*a* at left) Retraction of the muscles introducing stay sutures to steady the bladder. (*b*) Plunging the knife into the bladder between stay sutures. (*c*) Immediately placing finger in opening keeping the wound dry by sponging, examining the interior of bladder for foreign body and having funnel or button drainage tube ready for immediate insertion.

returned to his bed. *Management of the urinary drainage.* As soon as the patient reaches his room the stopper is removed from the drain pipe and the bladder emptied. If there has been only a small amount of residual urine, continuous drainage is allowed. If there has been a marked and long standing distention of the bladder, continuous draining should be avoided, the stoppered drain being opened at intervals of one to two hours as the case demands.

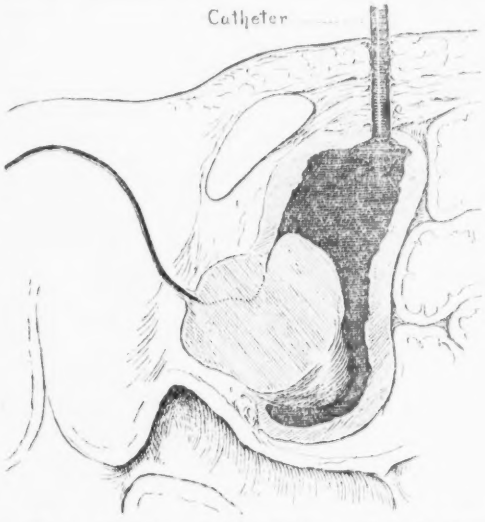



Fig. 6. The button drainage tube or catheter in place at high point in bladder with tissue planes sutured snugly about drainage tube entirely closing off prevesical and perivesical spaces. Experience shows that with this drainage point here the bladder would be kept entirely empty without any syphon drainage.

No attempt is made during the first three or four days following the operation to wash or medicate the bladder.

Whatever shock is going to take place from this encroachment on the urinary apparatus in cases of prostatic hypertrophy will become evident on the second to the fifth day after the suprapubic cystostomy. The patient is in the best possible condition to overcome this shock because there has been no loss of blood, no general anæsthetic, and no special pain, all of which factors tend to decrease the resisting powers of the organism.

*Results.* Primary union of the wound in practically every case.

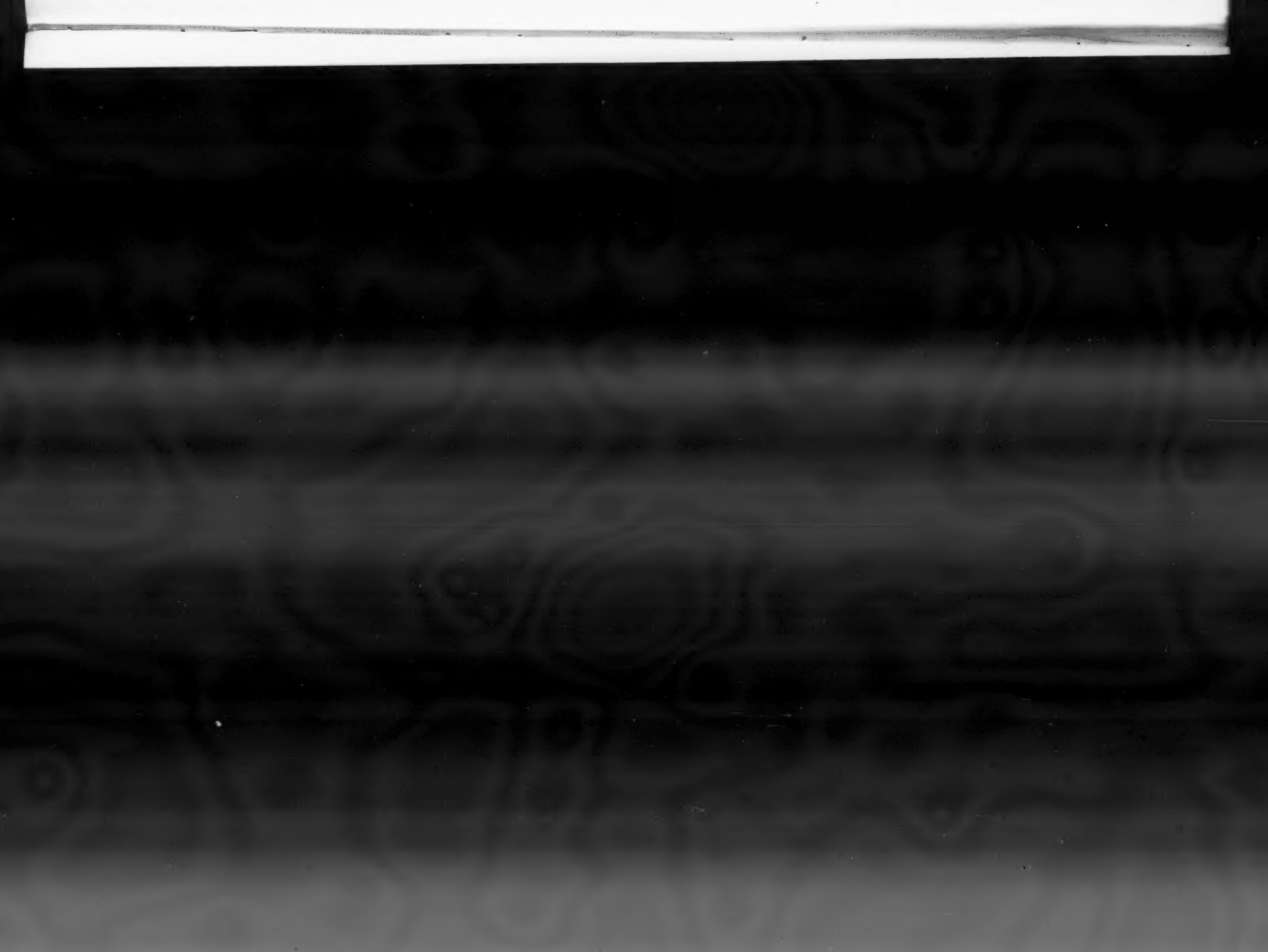
An absolutely dry wound without any urinary leakage.

Complete control of urine for tests.

Half of the operation completed without anæsthesia or surgical shock.

The elimination of the prevesical and perivesical spaces from the problem.

Makes unnecessary any further urethral instrumentation.



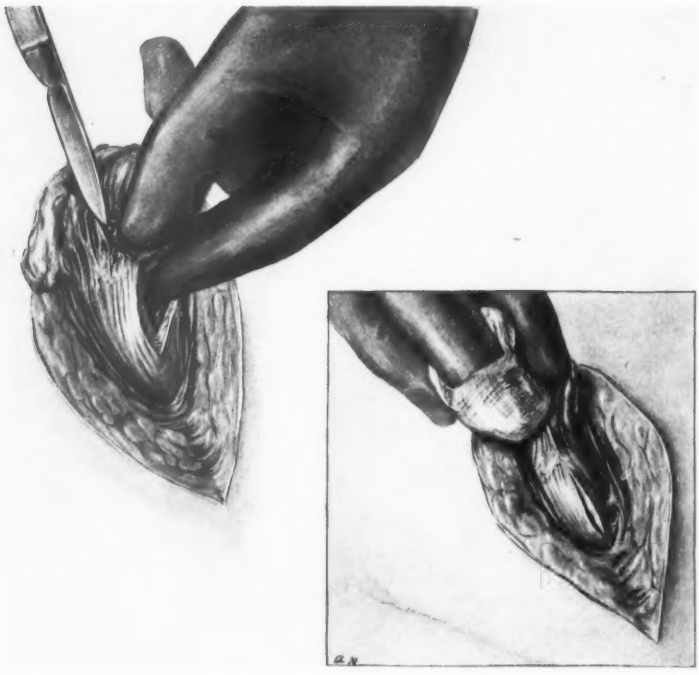


Fig. 7. Method of preparing a new site for drainage opening when one has found the first opening in the bladder too near urethral orifice. Finger in bladder locates peritoneal reflexion and with knife and sponge the peritoneal attachments are gradually reflected from bladder and new site selected.

PROSTATIC ENUCLEATION

*Preparation for the second stage.* When the time for removing the prostate has arrived, the patient is prepared for operation as before. All unnecessary catharsis, etc., on the previous day is avoided. The patient is placed on the table and iodine is applied to the skin around the drainage tube.

*Anæsthesia.* When all is ready the anæsthesia is begun. At our clinic we prefer ether administered by the drop method.

In cases in which the period of depression following the renal decompression is short, i.e., from one to two weeks, it is not necessary to use any instruments to enlarge the drainage opening; the silk skin sutures are still in place and should remain (Fig. 11). Where the skin sutures have cut out it is sometimes wise to reinsert heavy silk stay sutures to splint the wound and keep it from tearing open during the strenuous efforts often necessary for enucleating the prostate. Where a long interval is necessary between the first and second operation, it is frequently of advantage to enlarge the opening.

*Enlarging the suprapubic opening.* This is done as shown in Fig. 11 by three radiating incisions extending on each side of and downward from the opening. These incisions are not necessarily more than an inch in length and are all carried down through the subcutaneous fat to the sheath of the rectus muscle.

*Making the approach to the prostate easier.* If the patient is very stout and the thickness of the abdominal wall leaves the prostate out of our reach, it is indicated to remove sufficient of subcutaneous fat to allow the entire hand to pass as far as the sheath of the recti muscles. This reduces the intervening space

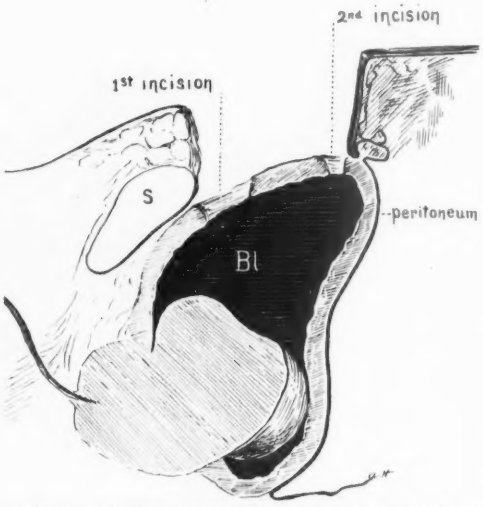



Fig. 8. Cross section showing first incision into bladder placed too low and point of second incision chosen higher up. A low incision is very frequently made in greatly distended bladders, because the anterior wall contracts with the bladder emptying and one finds only an inch or two between the bladder incision and urethral orifice.

between the hand and the prostate very greatly and makes the finger distance about the same in all cases. In cases where the approach is still too constricted to allow of complete control of the field of operation, the wound is enlarged by carrying the two lateral incisions deeper through the sheath of the recti muscles. Thus, any degree of exposure can be obtained without reopening the prevesical spaces. The incisions are not extended upward on account of the danger of injury to the peritoneum.

*The enucleation.* With the approach of the prostate provided for, the enucleation of the enlarged portions of the gland is accomplished by entering the index finger of the one hand (or in difficult cases the index and second finger) into the vesical portion of the urethra, slowly dilating it and seeking, if possible, the bandlike sphincter vesicæ (Fig. 12). Having located this an effort is made first, to separate the gland from the encircling sphincter by entering the natural line of cleavage which exists between the hyperplastic glandular masses and the muscular fibers (Fig. 13).

This is of advantage because, *if the internal sphincter is preserved*, the patient will gain control of his urine more quickly, and the control will be more perfect; and in the second place, we find that where this muscle is preserved,

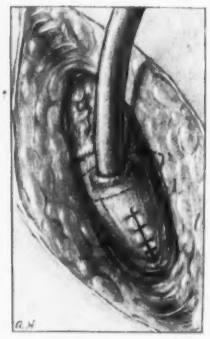


Fig. 9. First incision closed by suture. Second incision a stab incision through which button drainage tube is inserted. First incision is carefully closed over by prevesical tissues.

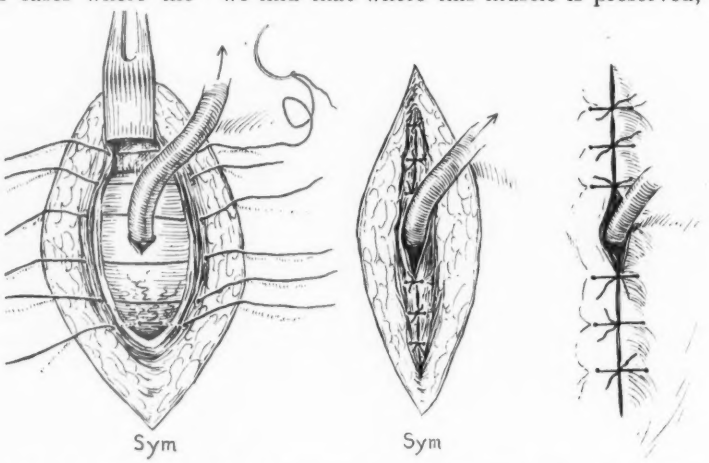



Fig. 10. Three steps in closing wound after suprapubic cystotomy. (*a*, left) Placing first sutures, the lowest suture closing off the prevesical space and including wall of bladder, the second and third sutures drawing together the rectus fascia and the upper three sutures drawing together the fascia below the peritoneal fold. (*b*) Further tying of sutures and closing the wound tightly around catheter. (*c*) Suturing the skin with silk. Closing wound around catheter without drainage. These wounds heal almost invariably without infection.

we seldom have any trouble from hæmorrhage following the enucleation, evidently because it causes a rapid contraction of the surrounding tissues. In the case of fibrous or muscular hyperplasia this separation of the sphincter is more difficult. In the cases with infiltration of the sphincter muscle, and especially where a median bar has formed, it may be indicated to remove a V-shaped wedge which will include part of the internal sphincter. In any case *all prostatic tissue should be cleared from the sphincter muscle.*

Having accomplished this, the finger is passed further along the urethra until the most distant part of the enlarged gland is reached. Here the lines of cleavage are sought and the enucleation accomplished slowly, gently and completely[1] (Fig. 14).

The enucleation will be greatly facilitated by introducing the index finger of the unengaged hand into the rectum and lifting the prostate up. The finger should be protected by a rubber glove.

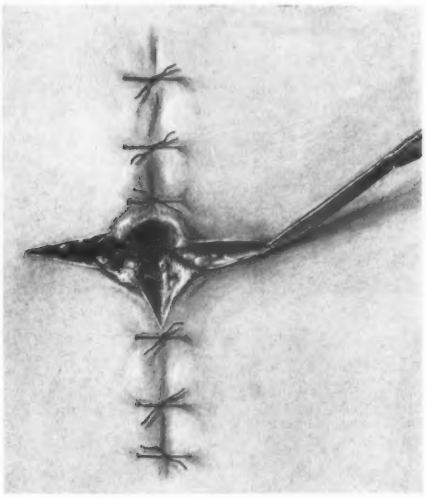


Fig. 11. Enlarging the suprapubic opening after cystostomy where a nearer approach to the prostate is desired. Note that there are two urethral incisions and one toward the pubis extending down only through the fat layer. In doing an enucleation of the prostate the skin sutures remain in place to splint the wound. The wound is not enlarged upward because of the danger of opening the peritoneal cavity.

[1]See Ann. Surg., Phila., 1914, Apr.

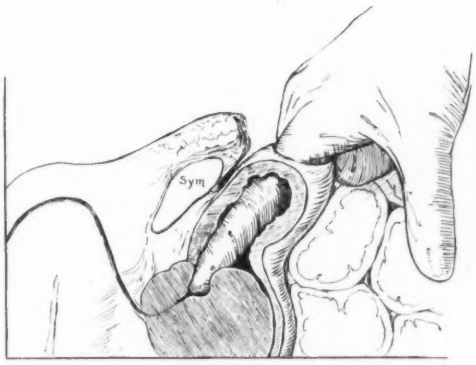



Fig. 12. In a great majority of cases without any enlarging of the wound, the finger is passed through the suprapubic sinus and enucleation of the prostate is begun from within the urethra.

*Technique of prostatic enucleation.* With the finger in the prostatic urethra, the point of least resistance in the mucous membrane of the urethra is sought. Usually this will be found on the lateral or the anterolateral wall of the urethra. At this point the division between the prostate and the urethra is usually quite easily broken through. In most cases one is able to gain the line of cleavage through the urethra easily with the

Fig. 13. After beginning enucleation of the urethral lobe the finger follows the sphincter muscles around the prostatic mass until the prostate is entirely free from it. If this is done before the prostate is removed, the sphincter can be entirely freed from all prostatic tissue and there will consequently be less bleeding.

Fig. 14. After freeing the internal sphincter, the finger is forced through the prostatic urethra to its most distal point and here the real enucleation of the gland is begun. With one finger in the rectum, which should always be gloved, and one finger in the bladder the gland can be almost entirely controlled. If enucleation with one finger is difficult, it will be found that by using the first and second fingers enucleation is facilitated.

gloved finger. The finger after entering the line of cleavage sweeps, first, slowly around the distal portion of the growth, and then, up over the anterior surface of the growth separating it from the encapsulating tissue. The finger is then passed across the urethra to the other side with a sweeping motion of the finger and the opposite lateral lobe is freed. Then passing the finger up over the entire mass an attempt is made to turn the growth over so that it will easily turn out into the bladder carrying with it the median lobe. That is to say, the finger is passed up over the two loosened lateral lobes and then beneath the same between the enlarged lobes and the rectum, and then the finger is pulled toward the bladder so that the growth will turn upon itself.

As the growth is turned out into the bladder, the bladder mucous membrane will be stripped up from its posterior surface. The point which is most difficult to free is the attachment at the junction of the prostatic and membranous urethra, which is seemingly a fibrous attachment, or may be the attachment to the atrophied posterior lobe which lies distal to the ejaculatory ducts and which probably is not removed in the majority of cases. It has been our experience that those cases in which the prostate does not shell out easily should be carefully examined for evidence of malignancy.

A peculiar type of prostate which is occasionally encountered is the enormous prostate which seems to be hypertrophied in all its parts with the exception of the median lobe. Such a prostate is seen in Figure 15. In removing this prostate it may often be more completely and more easily done by

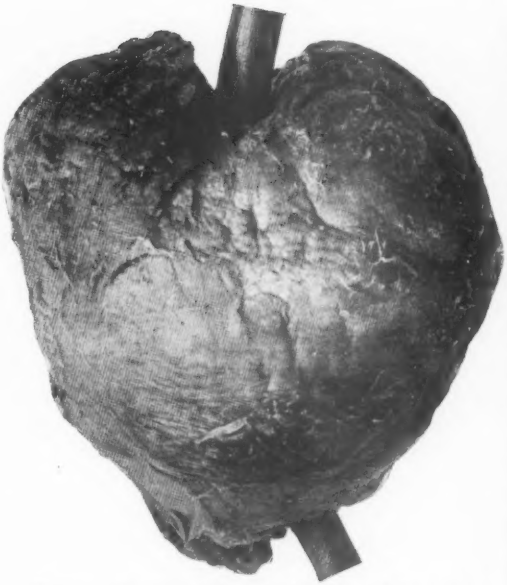


Fig. 15. Enormous bilateral enlargement of the prostate. Specimen removed in one piece.

passing the finger between the sphincter vesicæ and the growth itself and sweeping the finger around the growth, as recommended by Freyer. It will quickly fall out into the bladder. However, in the majority of cases the intra-urethral enucleation is to be preferred. It is quite essential for the welfare of the patient that all of the prostate as far as possible shall be removed. Thus, Figure 16 shows a prostate with a very large median lobe and two moderately enlarged lateral lobes, with many pieces of prostatic tissue which were dug out from the capsule after the main growth had been removed. The operator should never be satisfied with removing the larger hyperplastic masses alone, but an attempt should be made to bring away all the prostatic tissue possible unless there is a diffuse carcinomatous involvement. If fragments remain, they retard the healing of the cavity from which the prostate has been removed and are apt to necrose and cause a delay in the healing of the bladder.

It may be of great assistance to use the index and second finger together in freeing the glandular masses.

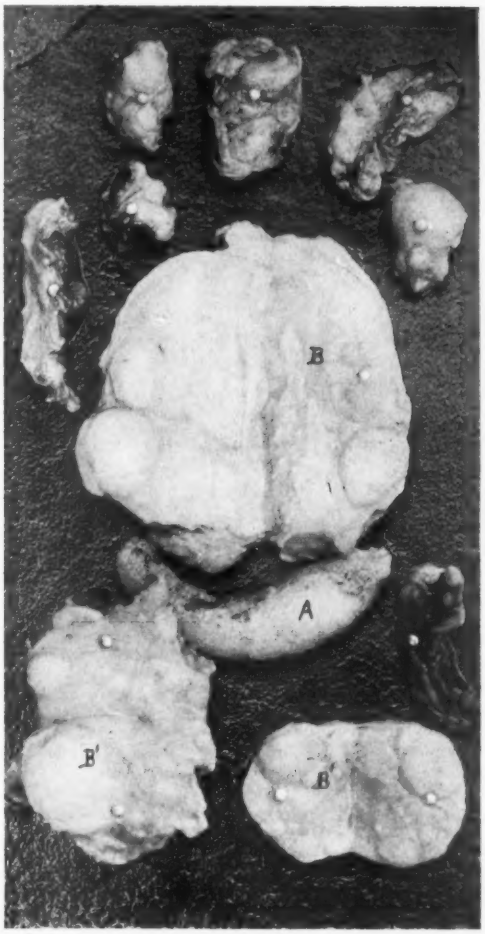


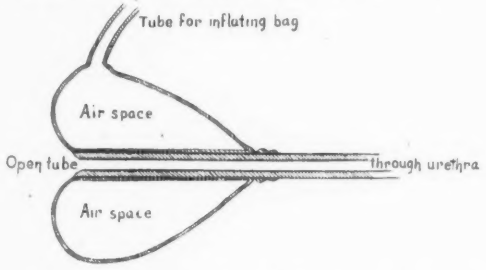

Fig. 16. Unequal enlargement of the prostate removed in sections together with crescent-shaped stone. Upper part of picture shows small hyperplastic bits of tissue removed from capsule.

*Following the enucleation.* 1. Remove all foreign material from bladder, i.e., blood-clots, the enucleated prostate, pieces of tissue, and most important of all, any small prostatic calculi which has been forced into the bladder during the enucleation. Frequently these calculi are overlooked and they enlarge and cause symptoms six months or so later.

A small gauze sponge is the best instrument to engage and remove the small calculi.

Fig. 17. The Pilcher hæmostatic bag. The device is a simple inflatable rubber bag fashioned about a large size catheter. Cross section in figure below shows structure of bag. The open tube catheter is entered first through the suprapubic wound over a silver catheter and drawn down through the urethra. When the bag is in the bladder with the tube in the urethra, the bag is inflated through the inflating tube and the inflated bag is used for pressure against the bleeding surface from which the prostate was removed. When pressure is desired the catheter attachment is pulled upon which brings the bag more tightly in contact with the bleeding surface. This pressure may be maintained by attaching the catheter tube to the leg. The catheter tube also acts as an avenue for the escape of the urine from the bladder.

The principle of the bag hæmostat was first suggested to the writer by Dr. Hagner, of Washington.




*Efforts should be made to control the hæmorrhage.* 1. By removing all the glandular masses or infiltrated tissue. This allows the cavity to contract, just as does the pregnant uterus after being emptied.

2. By direct pressure, one finger in the rectum and one in the bladder, placing all torn bits of attached tissue over the lacerated area. Fresh muscle-fibers will often seal the opening in a torn vessel.

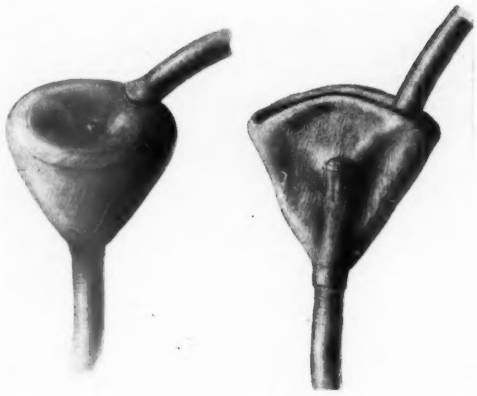


Fig. 18. The improved Pilcher bag hæmostat with wire protecting vesical end of catheter attachment.

3. By the bag hæmostat. We no longer use gauze packing to control hæmorrhage in these cases, on account of the uncertainty of its employment, the large amount of material necessary to secure absolute control of the bleeding, the unusual amount of sloughing of the bladder and wound following its use, and the pain and unnecessary disturbance of the healing surface caused by its removal. We have adopted the suggestion of Hagner

Fig. 19. Cross section showing position of bag hæmostat in place with inflating tube passing up from superior surface of the bladder and catheter tube emerging from the urethra.

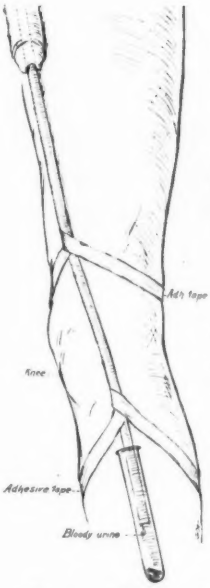



Fig. 20. Method of attaching catheter tube attachment of hæmostatic bag to the leg by means of adhesive plaster to keep up intravesical pressure on the lacerated tissues. Note test tube over end of catheter to receive urine from the bladder.

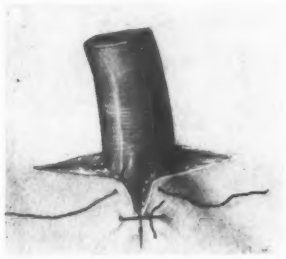


Fig. 21. Draining the bladder after enucleation. In every case of prostatic enucleation the bladder should be thoroughly drained. To do this a large calibre thick walled rubber tube, large enough to allow the blood-clots to escape if they accumulate, should be introduced. This tube is held in place by a silk suture, as in the figure. After the first few hours this tube is connected with a bottle and the bladder will keep itself empty and the patient dry.

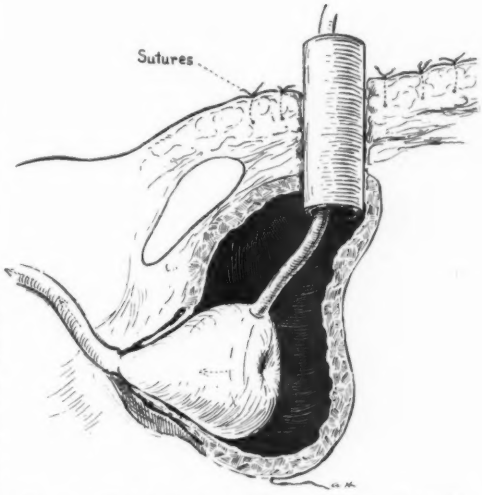



Fig. 22. Sketch showing complete drainage of bladder and hæmostatic bag in place. After enucleation of the prostate inflating tube passing up through or beside large drainage tube. In two or three hours the bag is allowed to deflate and the pressure is relaxed. If bleeding recommences, the bag is reinflated and pressure re-established. This bag is removed in twenty-four hours.

of Washington, which provides direct pressure on the bleeding surface by means of an inflatable rubber bag placed within the bladder, the degree of pressure being controlled by a rubber tube which passes down through the urethra, by means of which the bag is inflated and the bag held in contact with the lacerated surface (Fig. 17).

The writer has devised a bag hæmostat of this type which embodies some new features,

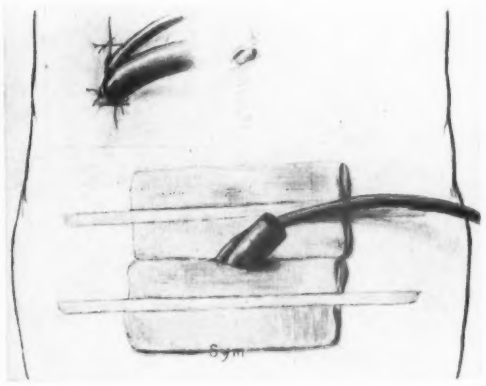



Fig. 23. Surface view of drain and dressing following suprapubic cystostomy in which bag hæmostat has been used, the smaller tube being the inflating tube of the hæmostatic bag.

Fig. 24. Types of button drainage tubes made for the writer for use after the second stage of transvesical prostatectomy. Simply modified Pezzer catheters, enlarged and reinforced to omit the special indications.

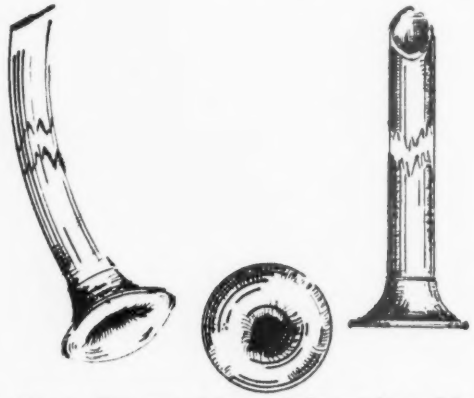


Fig. 25. New type of button drainage tube used by Dr. Pilcher in draining the bladder after transvesical prostatectomy. The tube is of large calibre, 26 to 30 French, heavy walled with an open bell of soft resiliant rubber with a very slight collar to hold the bladder-wall from slipping over it. This type of tube is self retaining and does not clog with phosphates or blood-clots as easily as the earlier types of tube used by the writer.

the object being to increase the comfort and safety of the patient. In addition, our bag provides for the drainage of the urine through the urethral tube (Figs. 18 and 19).

To place the bag, a well curved silver catheter is passed through the urethra into the bladder, after the prostate has been removed. The open end of the urethral tube of the bag is threaded over the end of the silver catheter and attached there by means of a silk suture passed through the eye of the catheter. The silver catheter is then withdrawn in the natural way bringing with it the rubber tube attached to the bag. This tube is then secured, the bag distended with air through the tube provided for that purpose, and with one finger in the bladder, the urethral tube is pulled upon, drawing the bag down into the neck of the bladder from which the prostate has been removed; at the same time all tissue tags and torn muscle-fibers are tucked in front of the bag and are brought in contact with the lacerated area. The urethral

Fig. 27. Strip of adhesive plaster used to fasten button drainage tube in place on the abdomen.

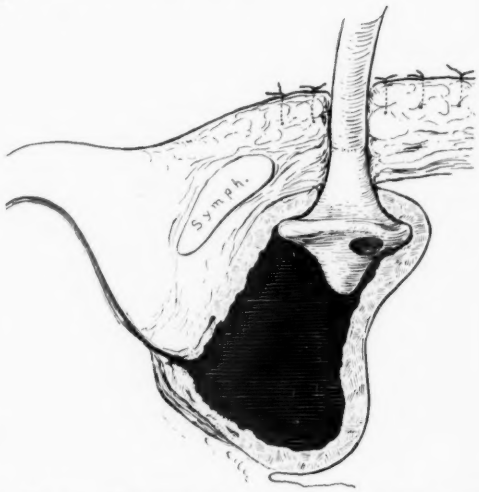



Fig. 26. After forty-eight hours' drainage tube and bag have been removed from the bladder and a large button drainage tube is inserted in its place. Within an hour or two the bladder-wall contracts about the narrow neck of the button drainage tube and all of the urine is collected through it, abdominal dressings remaining dry.

tube is attached to the leg by means of adhesive strips completely controlling the degree of pressure desired at the vesical neck (Fig. 20). By this means we have a safe and positive means of hæmorrhage control, which can be removed within an hour, if desired, and reapplied at will, without disturbing the

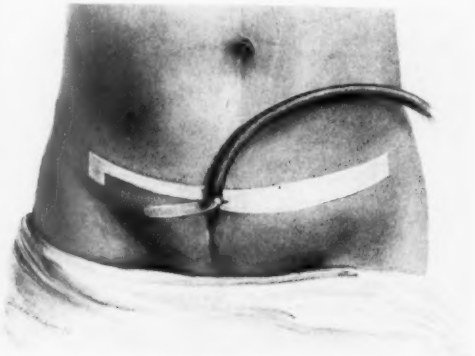


Fig. 28. Method of securing button drainage tube in abdominal wound to prevent its slipping out or in, and consists of a simple strip of adhesive plaster one piece of which crosses the abdomen and the other piece encircles the drainage tube and then is attached to the abdomen.

patient. Its removal at the same time that the drainage tube is changed is accomplished with relatively little discomfort to the patient.

*Drainage of the bladder.* This we consider necessary in every case of transvesical prostatectomy. A large size rubber tube is used, preferably about an inch in diameter. The tube extends only half an inch within the bladder and is fastened to the skin by a silk suture (Fig. 21). If a hæmostat bag has been used, the air tube is brought out through the drainage tube or beside it (Figs. 22 and 23). A large size glass connecting tube is attached to the drainage tube and a second rubber tube is attached to it, whereby the secretions from the bladder are collected in a bottle at the bedside. In most cases this will be most satisfactory and the patient will be kept dry for the first 24 hours following the enucleation.

*Management of the bag hæmostat.* With the bag inflated and in position, Figure 22, we have an absolute control of the hæmorrhage. The amount of tension exerted on the urethral tube controls the degree of pressure exerted on the torn periprostatic tissues. It is our practice to exert a considerable amount of pressure for the first hour after prostatectomy. The technique of maintaining this is best shown in Figure 20. At the end of an hour all bleeding will have stopped. The adhesive strips attaching the urethral tube to the leg are divided, the bag is deflated and it remains in place but exerts no pressure. The urethral tube in the meantime is functionating as a simple catheter and is draining the urine from the bladder into a bottle. In other words we have provided a double exit for the urine, and the result is added comfort to the patient, a dry clean wound, and a great reduction in the cost of dressings. If any bleeding should start up again it is a simple matter to dilate the bag again with air and reapply the pressure. The bag is removed in 24 to 48 hours.

*First 24 hours after operation.* If the patient is comfortable and dry and the draining tube is not causing pain or spasm of the bladder, he is not disturbed in any way. If desired he is allowed to sit up in a chair the day following operation.

If the bag hæmostat is causing trouble it may be removed together with the suprapubic drainage tube at the end of 24 hours, otherwise it is left in place for 48 hours.

*Forty-eight hours after operation.* The bag hæmostat and drainage tube are removed at the end of 48 hours. This is easily and quickly accomplished. The distal end of the urethral tube is cleansed and covered with vaseline. The suture holding the drainage tube is cut, and the tube and bag are slowly and gently withdrawn from the suprapubic wound. A long narrow retractor is immediately placed in the drainage tract to guide us in introducing the button drainage tube. Depending upon the character of the wound we choose a specially made pezzer or Pilcher catheter, or a button tube (Figs. 24 and 25). Grasping the enlarged end of the tube with a pair of dressing forceps it is passed down along the groove of the narrow retractor until the end enters the bladder. Then the forceps and retractor are withdrawn, leaving the button end of the tube in the bladder. In most cases the bladder-wall will immediately contract and hold the tube in place. In some cases this will take three or four hours. When the tube is in place it is carefully tested by using a small amount of irrigation to make sure that it drains the bladder. Frequently part of the irrigating fluid returns around the tube, but in practically every case the greater amount returns through the tube, if it is properly placed. When satisfied that the tube is properly placed it is fastened in place by an adhesive strip (Fig. 27), and the tube attached to an extension tube and bottle. In most cases this tube, if correctly placed, will drain all of the urine from the bladder, and after a period of a few hours will keep the patient perfectly dry. This we consider an enormous advantage to the patient (Figs. 26, 27, 28.)

At the end of 24 hours, some patients, and after 48 hours, most patients, are allowed out of bed. Common sense and not rules govern this phase of the subject.

### EDUCATION OF THE BLADDER

*One week after operation.* By this time the healing at the neck of the bladder is well advanced, and it is time to think of using the

urethra again. In one of our cases the suprapubic wound healed in four days. At the end of a week the button drainage tube is still in place, and in most cases the patient is still dry. In some cases there will be some leakage along the side of the tube. When the patient is dry we encourage the use of the urethra by the patient. We temporarily close the drainage tube and allow the bladder to partially fill with urine. Then the patient is told to try to void *per urethram*. It is surprising to note how many will succeed. The majority begin by passing a dram or two each time, every hour a little. At the end of 24 hours the patient will be passing an ounce or so every hour and gradually he is taught to resume his natural habit. All of this time we have the drainage tube as a safety valve. In a few days we find that most patients no longer need the tube, and it is removed. Some suprapubic leakage will occur for a day or so, but in many cases there will be very little after 24 hours. However, this depends to a considerable extent on the care and exactness with which the first stage of the operation has been carried out. I refer especially to the placing of the opening in the bladder and the reconstruction of the wound. The suprapubic opening heals rapidly and as a rule is entirely free from the necrotic, phosphate-encrusted tissues which was previously encountered.

The technique above described is applicable in the majority of cases of prostatic hypertrophy, and where followed out will give the patient the maximum of security with the minimum amount of suffering.

The various steps of the scheme can be best seen in review by referring to the following tabulation.

### Important Phases in a Two-stage Transvesical Prostatectomy

#### technique employed by the writer

*Renal decompression.* Preferably by means of a suprapubic cystostomy using button drainage tube (Fig. 6). Local anæsthesia.

*Drainage of bladder.* All urine collected through tube. No urinary leakage around tube. Patient dry. Out of bed.

*Second operation.* Transvesical finger enucleation of prostate. Ether anæsthesia five to ten minutes.

*First 24 hours after operation.* Patient dry. Urine drains through suprapubic tube, and urethral tube is employed.

*Second or third day.* Primary suprapubic tube out and replaced by button drainage tube. Hæmostat bag removed. Patient wet two to three hours.

*Third to seventh day.* All urine coming through button drainage tube. Patient dry. Out of bed.

#### education of bladder

*Seventh day.* Education of bladder begun with drainage tube temporarily closed during day, urination *per urethram* is begun. Every hour at first. Patient dry.

*Eighth to tenth day.* Education of bladder continued. Gradual lengthening of interval between urination to three hours. Patient dry.

*Eleventh day.* Wound well cicatrized. Button drainage tube removed. Urination continues. Slight urinary leakage.

*Thirteenth to twentieth day.* Sinus healed usually in three days.

# THE EVALUATION OF THE TRAUMA FACTOR IN HERNIA, MALIGNANCY, AND TUBERCULOSIS

By OLIVER J. FAY, M.D., F.A.C.S., Des Moines

THE apostles of medicine may be broadly divided into two groups: scientists and practitioners. The scientist deals with facts and with the working out of theories which are to establish facts. The practitioner, the man on the firing line, also deals with the world of things as they are, but its problems often take him beyond the realms of established scientific facts; he is called upon to answer questions for which science has as yet found no definite answers. He is not of choice an empiricist, but scientific investigation has not been able to keep pace with clinical needs, and he is forced to bridge the gap thus left with his clinical experience. Perhaps it is because industrial medicine is still a new field — I am speaking here of the science of industrial diseases and accidents, and not of medical commercialism and fee-splitting — that we are here confronted with the necessity of giving definite answers to so many unanswerable questions. It has been said that the only thing we actually *know* concerning the origin of cancer is that it is unknown, yet in the individual case the doctor is called upon to state definitely whether it is of traumatic origin. Hernia is of very frequent incidence, but the doctor must decide what few hernias are to be considered the result of industrial accidents. We do know the specific cause of tuberculosis; but we have come to look upon it as almost ubiquitous, and the doctor is expected to determine the part played by trauma in the development of any given lesion.

To the passing generation of physicians these questions were little more than interesting theories; to the physicians of today they have become of practical everyday importance. The development of social legislation rather than the development of medical science has been responsible for the change. Social legislation does not, it is true, belong to this century, nor even to the last. It dates back as far as the Middle Ages, but until the latter half of the nineteenth century medicine had small concern with such legislation, for it covered much the same field as do our charity and relief organizations of today. From the middle of the last century, even a decade or two earlier, industrial legislation began to concern itself with the organization and regulation of industrial insurance, in part maintained by the workingmen themselves, in part by the employers and by government appropriation. The Emperor of Germany in his message to the Reichstag in 1881 first advocated the adequate protection from injury of the workingman by the passage of compensation laws. Three years later such a law went into effect in Germany. In 1887, Austria passed a compensation law; Norway's first law providing for accident insurance dates from 1894. England's first real social legislation was enacted in 1897. Denmark, France, and Italy have had compensation laws since 1898, though in the two latter countries these laws are not universal in application. Hungary, Norway, Sweden, Belgium, Holland, Luxembourg, Switzerland, Spain, Finland, and Australia, all have compensation laws, though some of them are inadequate. In our own country, we have been slow in espousing the cause of the injured workingman; though 33 of the states and territories have enacted some form of compensation laws, the majority of such laws have been very inadequate. Yet these state laws forecast a nation-wide movement, and with the development of social legislation, there must come a corresponding development in practical medicine. Our fragmentary knowledge of trauma must be augmented; we must learn more of the role which trauma plays in the etiology of various diseases; we must learn to put an equitable value on permanent injuries; we must learn to make a prognosis in these cases, which is based on something

more than a guess. For in the evolution of social legislation, the time must inevitably come when all compensation cases will be taken out of the hands of an emotional and ignorant jury, out of the jurisdiction of the politician and lawyer, and be passed upon on their merits by the experienced physician.

His task will be no sinecure. The questions which we are today called upon to answer require all our knowledge and judgment, and all the assistance that can be gleaned from a study of clinical data. For discussion in this article, I have chosen three of the most widely-debated medico-legal questions — in so far as this is possible, I want to determine the value of the trauma factor in hernia, malignancy, and tuberculosis. Science has as yet given us no definite answer, yet from the practitioner a definite answer is required. The experience of the individual is too limited to serve as a basis for its solution, but the clinical experience of the many does afford the best criteria where science fails us, and it is on the basis of clinical experience and clinical data that I shall attempt to find answers to these questions.

To the lay mind, all or at least almost all hernias are of traumatic origin; the common use of the word rupture to designate a hernia characterizes his view of the matter. And this view has been more or less shared by the medical profession. In an old Italian surgery published in 1671 by one Fabritio, professor of surgery in the University of Padua, the causes of hernia are said to be either internal or external, and among the latter he mentions blows, falls, and the carrying of too heavy a load. With the recognition of the importance of a hernia anlage, traumatic hernia fell into more or less disrepute, and many doctors now maintain that a hernia is to be considered of traumatic origin only when it is the result of lacerating violence. Legally the term traumatic hernia has found a much more liberal interpretation; in many instances, any hernia developing while its bearer is at work has been held to be of traumatic origin. Even where the presence of enlarged inguinal rings could be demonstrated, the industrial accident was considered a contributary cause of the hernia, and the workman accordingly entitled to compensation.

Too narrow an interpretation of the trauma factor in industrial cases works hardship and injustice to the individual workman. But the workingman has been quick to seize upon opportunities offered by the compensation laws, and maintains, sometimes from honest though mistaken conviction, sometimes without this conviction, that any hernia entitles him to compensation. Too loose an interpretation of what constitutes traumatic hernia works hardship and injustice not only to the individual employer, and, by increasing insurance rates, to the employer as a class, but, indirectly, to the workingman as a class as well. In Germany it has been found that many manufacturers, in an attempt to protect themselves from this injustice, refuse to employ any man with hernia, or with a hernia anlage.

Recognizing the necessity for distinguishing between the hernia to which some industrial accident bears a causal relationship, even though a subordinate one, and the hernia to which it bears only a chance temporal relationship, is it possible for the examining physician to distinguish between the two?

Berger has divided all hernias into three groups: (1) hernia de violence; (2) hernia de force; (3) hernia de faiblesse. Though the French terms are more accurately expressive, I shall employ the simple English equivalents, or near-equivalents: (1) true traumatic hernia; (2) industrial hernia; (3) hernia disease.

In the first group, the hernia is the direct result of violence resulting in the perforation of the abdominal wall, or in suppuration, the hernia in either case protruding through the scar, as in a postoperative hernia. The traumatic nature of such hernias is universally recognized; their diagnosis is so obvious that I shall waste no time in discussing them, if only because a true traumatic hernia is the white blackbird of the hernia family.

It is about the second group, the industrial

hernias, that the battle royal wages, and these hernias make up the bulk of the hernias to be considered under the compensation law. In this class of hernias, there is no external sign of violence to stamp them as of traumatic origin, but a hernia is present, and its bearer insists that it is the result of an accident, a blow, a fall, overlifting, overstraining, slipping, indirect violence of whatever nature. The greatest difficulty is encountered in determining whether any given hernia is an industrial hernia, or whether it is in reality due to hernia disease.

Under hernia disease, the third group, we classify all those hernias which are the result of anatomical weakness, whether the hernia is present at birth, develops gradually over a period of years, or suddenly becomes manifest at some later period of life. The hernia anlage is present from birth; the actual hernia may develop at any time.

The uncertain boundary which separates the second from the third group is manifest. Brandenburg, who examined 3,810 workmen employed in digging the St. Gothard tunnel, found that 3.81 per cent had hernia — men whose hernia interfered with the performance of heavy work would, of course, not apply for such work — and that 80.2 per cent of the men had what he termed a predisposition to hernia, i.e., the external ring admitted at least the tip of the index finger. Schwiening reported that of 1,252,795 men examined for military service in Germany, the best of their men and in the strength of early manhood, 197,416 or 15.75 per cent had hernias. Zollinger examined 4,836 laborers; he found that 2,103 (43.4 per cent) had a slight tendency to hernia; 1,001 had a marked tendency to hernia (20.7 per cent); 228 had incomplete hernias (4.7 per cent); and 97 had fully developed hernias (2 per cent). While performing autopsies on 200 men, who during life had shown no signs of hernia, Murray found that 68 (34 per cent) had so well-defined a peritoneal bulging as to justify the term "sacculated hernia." Berger says that of 117 men who attributed their hernias to trauma, 96 (86 per cent) had other hernias of whose existence they were ignorant. It follows that the statement of even the most honest of men cannot be accepted without question.

Of the cases of supposed traumatic hernia referred to the chief insurance referee from the lower insurance tribunals of Germany in 1905, only 2 per cent were declared to be in reality traumatic; in recent years, a more liberal tendency has been observed and the percentage has gradually risen to 5, 6, and 7 per cent. A large percentage of the entire number of cases are, of course, settled without reference to this highest authority. Akerman, whose position makes his words authoritative in regard to compensation in Sweden, says that in 8 years he has had only 170 cases of traumatic hernia, and that after operation, 40 of these were rejected. He considers this number exceedingly small since there are 700,000 men who come under the compensation law, and 4,000 operations for hernia annually in Sweden. The bulk of what is written and said of traumatic hernia refers to inguinal hernia.

It is evident that the physician must have physical evidence to corroborate the statements of the patient, and those of his friends and fellow-workmen. In what, then, does this evidence consist? In France, in order that a hernia be adjudged traumatic, the national insurance bureau demands that:

1. There shall have been a direct contusion of the inguinal region, or that the work being done shall have required more than usual exertion.
2. The injured man must have been forced to stop work immediately following the accident.
3. He must have been forced to seek medical attention at once, or at most by the evening of the following day.

Brouardel, who cites these regulations, says that the following points must also be given consideration:

1. When a traumatic hernia first appears it is always of small volume. If the volume of a hernia exceeds that of an egg, one may be sure that the hernia antedated the accident.
2. In a majority of cases a traumatic hernia is unilateral. A bilateral hernia, or a unilateral hernia with a markedly enlarged ring on the other side, is strongly suggestive of hernia disease.
3. If the inguinal canal is little more than an orifice, the finger, which is introduced into it, enters the scrotum, the inner wall of the canal is weak, the idea of a traumatic origin may be rejected.

4. In traumatic hernia, the inguinal ring is small, hardly admitting the tip of the index finger; the introduction of the finger causes pain.
5. The presence of an ectopic testicle speaks strongly against the traumatic origin of a hernia; an ecchymosis is suggestive of such an origin.
6. Marked obesity and emaciation alike weaken the abdominal wall, and are to be considered as predisposing to hernia.

According to Borchgrevink, in Germany, the injured man is required to show that:

1. The injury received was of a character capable of producing a hernia.
2. The hernia appeared suddenly as the immediate result of the accident.

Injuries capable of producing hernia are defined as:

1. Direct violence to the inguinal region.
2. Slipping or falling while throwing or lifting some heavy object.
3. Heavy, though accustomed work, which was being performed under unusually unfavorable conditions.
4. Extraordinary exertion.
5. Extraordinary exertion from the standpoint of the age or strength of the workman.

In order to prove that the hernia was the direct result of the accident, it must be shown that:

1. He complained of pain immediately following the accident.
2. He was forced to give up work, for a time at least, immediately following the accident.
3. The doctor was called not later than the evening of the following day.

It is assumed that the forcing of an incipient hernia through the subcutaneous inguinal ring so that a complete hernia results is so serious a happening that a continuance of work is inconceivable, and expressions of pain and the desire to consult a physician are to be considered necessary results.

Inversely, Kaufmann holds that the following circumstances prove, or at least make it seem probable, that the hernia is an old one:

1. The previous demonstration of a hernia.
2. Signs that a truss has been previously worn.
3. The size of the hernia exceeds that of a lemon.
4. The hernia is irreducible, though not strangulated.
5. The inguinal canal is short and broad, its course only slightly diagonal.

As confirmatory, though not positive evidence against a traumatic origin, are to be considered:

1. The presence of a hernia on the other side.
2. An enlarged ring on the other side.
3. An ectopic testicle in the region of the hernia.
4. The fact that the claimant has done heavy work over a long period of years.
5. The advanced age of the claimant.
6. The claimant's admission that he has previously had difficulty in standing.

Many physicians hold that a hernia cannot be considered of traumatic origin if a hernia anlage existed; that in these cases the accident which immediately preceded the appearance of the hernia simply called attention to an already existing condition, or, at most, was only incidental to its development — the final straw which broke the camel's back. The law has, in most instances, put a more liberal construction on what constitutes a traumatic hernia, and it has been held that a workman is entitled to compensation if the accident is shown to have been the immediate cause of hernia, since, if it has not been for this accident, the anlage might have remained simply an anlage throughout life. For practical purposes, then, any hernia is considered a traumatic hernia when it is proved that the injury was the immediate, though not necessarily the sole, cause of the hernia.

The proviso that the injury to the inguinal region must have been due to direct violence, or that the accident or overexertion to which the hernia is attributed shall have been of a character capable of producing a hernia needs no explanation. Since there might be much discussion of what constitutes accidents capable of producing hernia, the more specific statements given are welcome aids: direct violence; slipping or falling while throwing a heavy weight; extraordinary exertion, whether extraordinary in an absolute sense or extraordinary from the standpoint of the physique or age of the individual, or the conditions under which the work was being performed.

In the main we must also admit that the

absence of pain and the ability to continue work are hardly compatible with the idea of a traumatic hernia. It must be borne in mind, however, that there are wide variations in the individual susceptibility to pain, and that a workman with steady nerves and a strong will might continue to work under conditions which would completely overcome a fellow-workman, might postpone a visit to his physician some days unless the hernia should become strangulated.

An industrial hernia is undoubtedly always small when it first appears, and to estimate its maximum size as that of an egg can hardly work an injustice. To me it seems less safe to say that in traumatic hernia the inguinal ring is always small, barely admitting the tip of the index finger. Brandenburg considered any ring which admitted more than the tip of the index finger, or the absence of a true inguinal canal, a predisposition to hernia, but his report of such a predisposition in 80.2 per cent of the men he examined seems to disprove this idea. Any condition present in four-fifths of the men cannot be considered abnormal, and we are, therefore, forced to conclude that no hard and fast rule concerning the size of the inguinal ring can be made.

A recent hernia is tender, and painful on manipulation, and an ecchymosis is not infrequently present. Immediate strangulation is common, and it is said that the majority of cases adjudged traumatic and granted compensation in Germany are cases in which the hernia was strangulated when it first appeared. Even the cases in which strangulation does not occur are difficult of reduction, but when once reduced do not come down again.

Strangulation always calls for operation, of course, but indications for operation in industrial hernias are in general far broader than in private practice. Practically all of these hernias occur in men who are performing hard manual labor, and the inconvenience and the danger of strangulation are accordingly increased. If the operation is undertaken early, it affords the best opportunity for definitely determining the nature of the hernia — traumatic hernia or hernia disease. Our law should be so modified that every probable industrial hernia would be entitled to operation and a reasonable time allowance for recuperation — and in a great majority of these cases, this should be the only compensation allowed.

In a recent traumatic hernia, the hernial sac is smooth and thin, and is not adherent to cord or ring, or at most such adhesions are of patently recent formation. There may be evidence of recent hæmorrhage and laceration. An adherent sac, a large inguinal ring with broad margins, a short broad inguinal canal, a patent tunica vaginalis, a thickened sac, a large hernia or one that comes down and returns with the simple changing of position, all these characterize the old hernia.

### MALIGNANCY

In any discussion of the cancer problem, one is met by the difficulty of having to deal with unknown quantities only — each and every premise must be represented by an X. It has never been possible to produce tumors experimentally with anything approaching convincing certainty, and until we do succeed in controlling our conclusions experimentally, we shall have to continue to speak in terms of probabilities and possibilities in discussing the relation of trauma to cancer.

We do know that the bruising of tissues may cause the tearing of blood-vessels, hæmorrhage, disturbances in metabolism, and the death of certain cell-elements, but we have absolutely no reason to believe that such contusions can cause true tumor formation. We do know that the great majority of tumors develop without any demonstrable preceding trauma, and that the countless accidents of our modern life, with its added industrial and traffic hazards, are followed by tumor formation in only a very small percentage of cases. We must, then, conclude that trauma can never be the direct cause of tumor formation, but only the indirect cause, by calling forth hyperæmia, inflammatory, reparative processes, a changed environment for the cell.

I shall not enter into any discussion of the different theories of the etiology of cancer;

so long as the great pathologists of our day are still unagreed, surely a surgeon may be pardoned for not rushing in where they fear to tread. Whether we accept Virchow's theory of external stimuli, or Cohnheim's theory of embryonal rests, or Ribbert's theory of postembryonal displacement, matters little. We know that tumors may develop following a trauma but that they do not necessarily do so; that trauma can never be the only and last cause of tumor formation. In order that trauma may give rise to a new-growth, specially predisposed tissue must be traumatized. Science has given us some idea of the nature of this special predisposition; in some cases an error in embryonal development seems very probable, an embryonal rest which has reacted to the stimulus of trauma; in other cases, a relationship between trauma and inflammation, inflammation and tumor-formation seems apparent; and finally there are the less mysterious cases in which the trauma has acted upon an area which was macroscopically abnormal, as, for instance, nævi and warts. The predisposing factor may be either local or general, but the predisposition must exist before trauma can give rise to tumor formation; of this we are fairly certain, but from here on we must depend upon clinical evidence, dispensing with scientific fact.

And even much of the clinical evidence is of uncertain quality, for in a majority of the earlier reported cases of tumor following trauma, the patient's account of the injury, often dating back many years, was the only evidence required; the nature and site of the injury were recorded only in the haziest of terms. Loewenthal, for instance, did a monumental work in compiling statistics covering 800 cases of tumor formation following trauma; but so many cases were included in which the causal relationship of trauma was so manifestly open to question, that his percentage conclusions are of little real worth. Then, too, practically all of the older statistics included chronic irritation or repeated injuries under the head of "trauma," and according to the present-day industrial interpretation of this term, this is not permissible. Von Buenger urged a standardizing of the statistics on trauma and tumor, and with this object in view recommended that the reports from various clinics cover a five-year period and deal specifically with two points:

1. The entire number of tumors coming under observation during a given five-year period, including a statement of the type and localization of each tumor.
2. An accurate statement of the number of cases in which the tumor could be attributed with certainty, or with a probability bordering on certainty, to a single severe trauma. The character of the trauma should be accurately stated.

There were several responses to von Buenger's request, many of the largest German clinics being represented, and the effect of such standardization at once became apparent. In the earlier statistics, or those not compiled in accordance with von Buenger's conditions, we find the incidence of the trauma factor rated as high as 44.7 per cent (by Loewenthal). The later statistics, answering von Buenger's requirements, evidence the wide variations which we would expect where so much depends upon the individual judgment of what constitutes a relationship between trauma and tumor, but these later percentages have this in common, that they are far lower than the older ones had been. In 4.24 per cent of Machol's cases, the patients held that their tumors were of traumatic origin; he himself accepted this statement in only 2.06 per cent of the entire number of cases. Wolff gave a percentage of 14.3; Liebe of 10.8; Wuerz of 5; Seidener of 3.9 per cent in his carcinoma cases, and of 14.19 per cent in his cases of sarcoma.

Any discussion of the value of the trauma factor leads naturally to a discussion of the conditions under which trauma is to be considered a probable, or even a possible, cause of the tumor formation. Jordan asserts that a clinical observation is of value only when:

1. The contusion has been observed by a physician, and its exact location noted.
2. The location of the tumor exactly corresponds with the site of the injury.

3. The time between the receipt of the injury and the appearance of the tumor is in accord with the probable period of development of a tumor of this given type.

4. It is proved that a tumor did not exist at this point at the time of the injury.

To me it seems that these requirements are impossible of fulfilment. Many contusions, even those of a severe type, are not seen by a physician, and the testimony of fellow-workmen as to the severity and site of the injury would seem to be all that could be reasonably required in certain cases. Loewenstein says that there are cases in which the accident is given so little thought, even by the patient himself, that it is not reported, yet at autopsy, death having resulted from a tumor, signs of injury, such as remnants of an old hæmorrhage, are found about the new-growth. The third condition would also require a very free interpretation; we know that following operation there may be a local recurrence in a few days, or only after some years, and this in tumors of the same type. Is it too much to assume that there may be an equally wide difference in the rate of development before operation? that then, as later, a cancer may have been quiescent and its presence unsuspected for years?

Loewenstein has found a more practical working basis. He requires the following proof of the traumatic origin of a tumor:

1. Credible proof of the receipt of the injury, to be brought by the claimant, or to be shown by the investigations of the judges at the beginning or close of the malady which later manifests itself as cancer.

2. The accident must have been of a nature which makes probable the injury of the part which later becomes affected with cancer, though it need not have acted directly upon it.

3. The accident, the intermediate or premonitory symptoms of cancer, and the cancer itself must bear a clear relationship to each other.

4. The disease which is attributed to trauma must have developed subsequent to the injury, and at a time which makes probable a causal relationship, due consideration being given to the morbid anatomy and the clinical type.

These conditions accord in a general way with those laid down by other medico-legal writers, particularly by Thiem, who, however, defines the nature of the trauma somewhat more clearly. He says that the injury must have been severe enough to cause immediately appreciable effects, both from an anatomical and a functional standpoint, giving rise to credible symptoms which may later subside. He also makes more specific statements concerning the premonitory intermediate symptoms, the "bridging symptoms," as he terms them, and the interval of time which may elapse between the injury and the first manifestation of the new-growth. He lays special emphasis on these bridging symptoms, particularly in the case of neoplasms developing after the passage of some time. The possibility of a causal relationship between an injury and a tumor developing after the passage of two or three years is very slight unless such symptoms have existed. An exception is made in the case of gliomata of the brain, which are known to be of very slow growth. Though Thiem usually accepts two years as the time limit in cases of sarcoma, three years in cases of carcinoma, he admits that the interval may be a much longer one if the existence of "bridging symptoms" is very clearly shown. As the minimal time limit, he accepts not less than eight days in sarcomata; not less than 3 or 4 weeks in carcinomata. I believe that this is rather an error in favor of the claimant and that tumors appearing in so short a time have been stimulated to more rapid growth by the trauma, rather than that they have been caused by it. Certainly, we need have no fear of working an injustice to the patient when we accept his standards.

### TUBERCULOSIS

In considering the part played by trauma in the etiology of tuberculosis, we are treading upon more certain scientific ground. We know at least that tuberculosis is due to a specific organism, and from this we know that trauma can at most be only a contributary cause; it cannot produce tuberculosis; at most it may determine its localization. In how far, then, and under what conditions, is this possible?

Thiem says that, in considering trauma and tuberculosis, there are four distinct possibilities to be taken into account:

1. A tuberculous infection in a person not previously tuberculous.
2. The manifestation of a tuberculosis which was already present, but which, up to the time of the injury, had remained latent.
3. The tuberculous infection of the injured area from a tuberculous focus somewhere else in the body (metastatic tuberculosis).
4. The simple exacerbation of an old tuberculosis already manifest at the site of the injury.

The greatest number of cases coming under the first head are those due to inoculation, i.e., to the tuberculous infection of open wounds. The possibility of such infection has been proved experimentally as well as clinically, and needs no discussion. Superficial wounds seem more liable to such infection than do the deeper wounds which bleed freely. Probably the great majority, if, indeed, not all tuberculous ulcers of the skin, even in people having other tuberculous foci in the body, are due to such inoculation rather than to hæmatogenous infection. Penetrating wounds of the lung are sometimes followed by tuberculosis. Brouardel says that Demme lost 17 patients with tuberculosis, of a total of 159, with penetrating wounds of the lung. The possibility of infection of the lungs in this manner cannot be denied, but I believe that Demme's percentage of occurrence is extraordinarily high.

It would seem not improbable that tuberculosis of the lungs might have a similar origin following subcutaneous laceration or contusion of the parenchyma, inoculation resulting from the inhalation of tubercle bacilli. Practically, however, traumatic tuberculosis of the lungs of this origin can at most form only an infinitesimal percentage of the entire number of cases of tuberculosis attributed to injury. Most of the cases supposed to have originated in this fashion fall under the second and the third head.

In the second group are classed those cases in which tuberculosis was present, though latent, at the time of injury, and only was made manifest by it. If the injury was a severe one, the shock and the lessened resistance due to it and to the resulting confinement to the house or the bed may activate the process. But in tuberculosis of the bones and joints, particularly in children, there is still another class of cases which come under this head: those cases in which the tuberculosis is the cause of the accident, and not the accident the cause of the tuberculosis. The painless, insiduous onset of tuberculosis of the knee, less frequently of the hip, has escaped observation, but it causes the fall which results in a minor injury to the affected joint. Attention is thus attracted to it, and the tuberculosis is mistakenly supposed to be the result instead of the cause of the accident.

The third group is the one most readily controlled by experiment, and repeated efforts have been made to determine tuberculosis in a given bone or joint by traumatizing it immediately before or after the introduction of tubercle bacilli into the blood stream. The results of these experiments have not been convincing. Krause and Schueller obtained positive results; Lannelongue and Achard, Honsell, and Friedrich negative ones. The last two authors concluded from their experiments that the relationship between trauma and tuberculosis observed clinically in man was due solely to the lighting up of an old tuberculous process. It can, of course, never be proved that a tuberculous bone or joint was free from a latent infection prior to the receipt of the injury which gave rise to symptoms, but from the practical and the legal standpoints, it is sufficient to show that there had been no symptoms of such an infection prior to the receipt of the given injury.

On the 1,703 cases of tuberculosis of the bones and joints, which Honsell reported from the Tuebingen clinic, 242 were of probable traumatic origin. In 88 of these cases the tuberculosis appeared as the direct result of the injury; in 100 cases, following the injury, there was a period of improvement before symptoms of tuberculosis supervened. In the 54 remaining cases, the patient had been free from symptoms for a time preceding the appearance of tuberculosis. Wiener, from Mickulicz' clinic, reported a series of 436 cases of tuberculosis of the bones and joints; of these 125, or 28.6 per cent, were attributed to a preceding trauma; 26 cases, or 6 per cent of the entire number, gave a

typical picture of traumatic tuberculosis, i.e., the relationship between trauma and tuberculosis was a more or less direct one. In 54 cases, or 12.4 per cent, there was a short period of incubation between the time of the injury and the development of the first symptoms of tuberculosis. From the Bonn clinic 261 cases were reported, and of these, 23, or 10 per cent, were attributed to trauma. Not all of these, however, bear the closest scrutiny. Thiem reported 405 cases, in 123, or 30.3 per cent, of which a causal relationship with trauma was to be established. He states that such a relationship is evident in 20 per cent of all cases of localized tuberculosis.

In many of the cases of tuberculosis belonging to the third group, trauma probably plays a dual rôle: the traumatized area is not only predisposed to infection by the increased blood supply and stasis, but tubercle bacilli are liberated from old, dormant foci, either through the mechanical insult or secondarily, by inflammation.

Under the fourth head, we may group those cases of tuberculosis which were manifest before the injury, but which were exacerbated by it. These cases differ from those of the second group in one important particular: in the latter group, the previous existence of tuberculosis was unknown. We may feel confident that it did exist, but we lack definite knowledge concerning it. In the fourth group we are dealing with a known quantity, if, indeed, a physician may ever claim to deal with known quantities. The tuberculosis had been recognized, the stage of its development was approximately known. We thus have an established basis of comparison by which to judge of any post-traumatic changes in the patient's condition.

In estimating the probable value of the trauma factor in any given case of tuberculosis, the nature and severity of the injury are first to be considered as in other traumatic lesions. If the thorax is the part of the body injured, in addition to the usual considerations of the force applied, local subjective and objective symptoms and their duration, special interest attaches to the presence of dyspnœa and hæmoptysis. Brouardel insists that in examining any patient following an accident in which the thorax has been traumatized, however slightly, the lungs should be carefully examined, exact notes made on any abnormal condition, and the site of the trauma noted, though it is a mistake to suppose that a traumatic tuberculosis necessarily develops near the site of the injury.

The second point to be considered in passing upon these cases is the previous health of the individual. If we have to do with an advanced tuberculosis, there can be no doubt that it antedated the injury. But if before having manifested obvious symptoms of tuberculosis, the claimant's health was poor, he had a chronic cough, frequent attacks of bronchitis or pleurisy, if he was often obliged to give up his work, we may also assume that the tuberculosis is not of recent origin. Inversely, if he has been in apparently good health and has worked without interruption, we must conclude that the tuberculosis, though not to be absolutely excluded, was at least latent, and that it would probably not have become active had it not been for the injury.

The time relationship between the trauma and the first evident symptoms of tuberculosis is also of importance. Marix, in tabulating statistics from the Prussian war office, reports 94 cases of tuberculosis following trauma, and in a part of these cases exact notations of time are given. In 7 of these, the bacilli were found in from 6 weeks to 3 months following the injury; in 8 cases, 3 to 11 months elapsed; in another case the disease was clinically recognizable after 7 months, although no bacilli were found. In a second group of cases, it is assumed that the tuberculosis was instrumental only in causing a flare-up of an existing lesion. In 9 of the latter, the tuberculosis became manifest between the sixth and the thirtieth days; in 3 additional cases before the end of the third month. In a third group of 6 cases, from 22 to 40 months had passed before the manifestation of tuberculosis, and this interval was considered too long to permit of the establishment of a causal relationship. Kaufmann considers that such a relationship cannot be established after the passage of

more than a year; Jordan thinks that it should not be more than a few months; the German law gives a two-year time limit, to which Thiem subscribes, though he thinks that the presence of intermediate or "bridging" symptoms — pain, stiffness, or slight fever — may make an interval of many months, or of years, no evidence against a traumatic origin. The usual interim he places at 4 to 10 weeks. Where the tuberculosis becomes manifest within 4 or 5 days, the presence of a previous active infection is demonstrated, for the tubercles do not begin to develop until 3 or 4 days after contamination, and attain full development only after from 12 to 14 days.

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# SYPHILIS OF THE BLADDER

## Report of a Case and a Review of the Literature

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THE purpose of this paper is to report a case of syphilis of the bladder, and to review briefly the literature on the subject. Until quite recently vesical syphilis was considered to be very rare, and some authorities even doubted or denied its existence. With the widely developed use of the cystoscope and the perfection of reliable laboratory tests, our knowledge of diseases of the urinary apparatus has been wonderfully increased; and it must be admitted, as a result of recent investigations, that syphilis will have to be given a more prominent place in the etiology of urinary disturbances.

Functional disturbances of the bladder associated with the so-called parasyphilitic diseases of the central nervous system (tabes, paresis, etc.), are well known, and are mentioned because they may be the first manifestations of these diseases, and are usually readily recognized by cystoscopic examination. Also, the invasion of the bladder by the direct extension of gummatous processes in the vagina, uterus, and rectum are recognized; and may produce what Neumann (1) has described as "syphilitic paracystitis," developing finally into an acute or chronic catarrhal cystitis; and in some cases there may be a perforation of the bladder-wall from without due to the breaking down of a gumma.

When it is so well known that the spirochæta of syphilis shows no discrimination in its attacks upon all the tissues and organs of the body, it seems strange that so few cases of its direct action on the bladder have been described.

There is yet but little literature on the subject, most of which is German and French: in America only three cases have been reported, Morris, MacGowan, and I. Simons.

Kelly and Burnam (2) in their recent treatise on the kidneys and bladder give the subject brief attention; they quote several cases reported in the recent literature, and describe the common symptoms and lesions as described by various authors.

Nitze (3) says that up to 1907 he had not seen a syphilitic process in the bladder; Frisch and Zukerkandl (4), in their *Handbuch der Urologie* 1904–1906, say nothing on the subject; Casper (5) merely mentions it; Desnos and Minet (6), writing in 1909, doubt the existence of luetic lesions of the bladder; Guyon (7), quoted by Lèvy-Bing (8), says "the urinary apparatus may rightly be regarded as escaping syphilitic lesions . . . . though very exceptionally the kidneys may be directly affected." Legueu (9), writing in 1909, says that syphilis of the bladder is very rare; Fournier (10), in his work on syphilis in 1899, does not mention syphilis of the bladder; and Noguès (11), in the second edition in 1906, denies its existence.

Margouliès (12) in 1902 reported three cases which he had observed, and gave abstracts of thirteen other cases which he had collected from the literature up to that time. Of the thirteen cases, seven were autopsy reports on bodies which showed other lesions of syphilis besides those found in the bladder. Morgagni (13) in 1767, a report of multiple ulcers of the vesical mucosa and tertiary lesions on the tongue and epiglottis; Follin (14), a report of twelve lentil-sized vegetations of the vesical mucosa, and destructive lesions of the palate and liver; Ricord (15) in 1851, a report of two cases showing extensive ulceration of the base of the bladder; one case having had a phagadænic ulceration of the external genitals, and the other case an acute suppurating process of the prostate and seminal vesicles. These two cases are disputed by Noguès, but Asch (24) thinks that the first case may have been one of a malignant form of syphilis. Virchow (16) in 1852 reported a case of disseminated tertiary le-

sions throughout the body (of an old woman), and the bladder very much contracted, with extensive ulcerated vegetations scattered over the mucosa which was everywhere greatly swollen. Vidal de Cassis (17) observed a case of perforating ulcer of the bladder (gumma); Tarnowski (18) a case of superficial ulceration of the base of the bladder and posterior urethra in a four-year-old male child; there was a very extensive secondary eruption over the entire body and mucous patches in the throat.

The remaining six cases were observed clinically, the diagnosis having been based upon the accidental discovery or the later development of other syphilitic lesions; cases of Griwzow (19) who reported two; Morris (20); Chrzelitzer (21); Matzenauer (22); and MacGowan (23). The latter two were also observed cystoscopically. Matzenauer was the first to observe and describe syphilitic lesions of the bladder through the cystoscope: his case, a female, presented a chipped out ulcer extending from the roof of the urethra to the base of the bladder, and at the internal orifice were several polypoid vegetations from some of which filaments floated freely in the bladder. It is interesting to note that the cases of Chrzelitzer and MacGowan were treated for some time for cystitis, prostatitis, and attacks of retention of urine before syphilis was suspected as the cause of the trouble. MacGowan found a circular group of small ulcers near the right ureter, their edges thickened, and from their ragged bases filaments of sphacelated tissue floated freely in the bladder. Both cases recovered promptly after mercurial treatment.

Margouliès' three cases complained of persistent hæmaturia and painful frequent micturition. Two were cystoscoped. In one was seen, just external to the left ureter, a group of three pea-sized tumors surrounded by an area of light hyperæmia; he made a diagnosis of carcinoma, but as the patient refused operation, and as she had had a seven months' abortion some years previously, he put her on mercurial treatment tentatively. To his surprise all symptoms rapidly disappeared, and after three months only a faint scar remained where the tumors had been. The second case had the most violent and unrelievable pains in the bladder; and on examination a linear ulcer was seen just above the left ureter, which disappeared completely after mercurial treatment. The third case was not cystoscoped until after recovery; the patient was a tabetic, and only a trabeculated bladder-wall was to be seen; hence this case cannot be considered as one of actual syphilis of the bladder, though he recovered from the urinary distress.

The most recent studies of the subject are those of Asch (24) in 1911, and Lèvy-Bing (8) in 1912 and 1913. Each of these authors has gone over the subject in the most thorough manner; the publication of Asch being the most exhaustive study of the subject to be found in the literature. Asch has reviewed and critically analyzed all of the cases reported to that time, and confirmed most of them as authentic. He reports three personal cases, two of tertiary syphilis of the bladder, and one showing secondary lesions. The tertiary cases had persistent hæmaturia and painful micturition. In one was seen, just external to the left ureter, a papillomatous tumor the size of a small nut, behind and partly concealed by which was an ulcer about one centimeter in diameter, with indurated margins, and the base covered with a yellowish exudate. The second case presented a large gummatous ulcer at the base of the bladder. The third case showed twelve small superficial ulcerations scattered over a red and swollen mucosa, resembling the secondary lesions seen on other mucous membranes. All three cases recovered promptly on mercurial treatment alone, and the lesions disappeared.

Lévy-Bing reported one case of secondary syphilis of the bladder, characterized by having no vesical symptoms, but showing, on cystoscopic examination, a patch of moderate hyperæmia just back of the trigone, and on this were a number of small superficial ulcers. He observed this case through the routine cystoscopic examination of all cases in his clinic presenting a secondary eruption on the body. He states that in the secondary stage it is not uncommon to find areas of increased vascularity of the vesical mucosa, though

there may be no urinary symptoms; and he believes that secondary lesions will be found to be more common if there is more search made for them in this stage of the disease. They will not necessarily cause vesical symptoms.

In addition to the cases already cited, Asch and Lèvy-Bing collected thirteen other cases from the literature, all of which were observed cystoscopically, and recovered after mercurial treatment alone. A résumé of the cases follows:

Le Fur's (25) case showed three ulcerations in the region of the trigone. This case was of special interest because of a large nodular infiltration in the right lobe of the prostate, because it was treated for some months for cystitis and prostatitis, and because the final diagnosis was made only after the development of mucous patches in the throat.

Graffe's (26) case showed a deep ulceration of the bladder-wall.

Englemann (27) had three cases. One showed a large ulcerating tumor near the right ureter; the second showed a small partly ulcerated tumor in the same position, which was at first thought to be a carcinoma; and in the third, which presented some marked signs of tabes, there was a large elevated and incrusted ulcer on the lateral wall of the bladder. The lesions in all three cases disappeared completely after mercurial treatment.

Nin Posadas (28) reported a case of gummatous ulceration.

Picot (29) reported a case which had been treated for seven years for chronic cystitis; in the region of both ureters were numerous superficial ulcers with pale bases and red margins, placed upon a hyperæmic patch of the mucosa; the apex of the bladder was covered with discrete and confluent ulcerated tubercles. All tests were made for tubercle bacilli without result; and the patient recovered with mercurial treatment alone.

Pereschiwken (30) reported three cases of secondary lesions of the vesical mucosa, all being characterized by multiple small ulcerations. In the first case the mucosa at the base of the bladder was swollen and hyperæmic, and in the vicinity of the left ureter were several ulcerations with elevated and infiltrated margins. In the second case there were seven small ulcers at the apex of the bladder. The third case showed a vesical mucosa greatly injected, the vesical sphincter œdematous, and scattered everywhere were ulcers of various sizes, some with infiltrated margins and others with flat margins. All recovered rapidly with mercurial treatment alone.

E. Frank (31) at the Second German Urological Congress, Berlin, 1909, presented seventeen cystoscopic pictures of two cases of secondary syphilis of the bladder, showing the lesions before, during, and after treatment.

Michialis (32) reported a case of secondary syphilis, the mucosa showing multiple small vesicular lesions surrounded by a rose-colored zone, and on the anterior superior wall were many red spots resembling those seen on the skin in roseola.

In addition to the cases collected by these authors, five others are to be found in the recent literature, which brings the total of all cases so far reported to thirty-eight, of which twenty-five have been reported since 1902.

In 1911 Haberern (33) reported a case showing a large gummatous ulcer on the trigone, and a large tumor on the lateral wall near the vesical orifice; the mucosa was everywhere smooth and glistening; the Wassermann reaction was positive. Twenty days after one injection of salvarsan the ulcer had disappeared, and the tumor was reduced to a very small size.

In July, 1914, Gayet and Favre (34) reported three cases. The first was an old man with marked tabetic symptoms. There was multiple ulceration of the mucosa, which, in the presence of tabes and an infected urine, must be considered as a doubtful case of direct syphilis of the bladder. The second case, a female, showed the base of the bladder elevated as a projecting fold, greatly resembling the projection of a median prostatic lobe. The mucosa here was deep red, and in places showed small ulcerations. The third case, a female, showed a similar swelling at the base of the bladder close to the vesical orifice, the mucosa over and surrounding the area being of a deep red color, but there were no ulcerations. In all three cases the Wassermann reaction was positive, and disappearance of the lesions followed antisyphilitic treatment.

I. Simons (35) in 1913 reported a case which was interesting because of the rapid development of the ulceration at the base of the bladder, and the absence of any syphilitic history whatever.

The symptoms of syphilis of the bladder present no characteristic features which would at once arouse suspicions. The patient's attention may be attracted to the bladder because of the discomforts usually accompanying an ordinary cystitis; or the first symptom may be a sudden hæmaturia, which may be unaccompanied by any pain or discomfort whatever, and may continue painless throughout the course of the disease. In the majority of cases there is painful frequent micturition, accompanied at times with terminal hæmaturia of various degrees. In the tertiary stage hæmaturia is almost always present; it may be marked from the first, or appear at intervals which become shorter as

the attacks increase until there is, finally, a total hæmaturia.

Lévy-Bing (8) says that the secondary lesions may occasion no symptoms whatever, but usually the symptoms consist of increased frequency of micturition, day and night alike, and pain at the neck of the bladder, referred to the end of the urethra, the perineum, genitals, and to the abdomen. In the early stage the pain is relieved for a short time after the bladder is emptied, but soon recurs, and is usually very marked during the act of voiding.

One of the striking features of most of the cases reported was the extreme sensitiveness of the bladder to the solutions introduced for cystoscopic examination. In both the secondary and tertiary stages, the pain is more marked the closer the lesion, especially an ulcer, is to the vesical orifice. In one case the pain at the neck of the bladder was so intense that no remedy would give relief. Urgency is another symptom which is always marked. Thus, the symptoms are not much unlike those of renal and vesical tuberculosis.

The urine may show nothing except a few red blood-cells and some pavement epithelium in the secondary stage; or it may be more or less murky, due chiefly to red blood-cells, mucous and epithelium, with a relatively small proportion of pus-cells.

In the tertiary stage the urine contains a larger amount of blood; but unless there has been some secondary infection there is here also a relatively small amount of pus.

Bacteria are characteristically absent except in cases of secondary infection with the usual benign or pyogenic organisms.

There has been no case reported where the spirochæte was found in the urine.

The type of the lesion varies according to the stage of the disease. In the secondary stage one may see small macules resembling those of roseola, or small multiple superficial ulcerations surrounded by a zone of light hyperæmia, as seen on the other mucous membranes. The ulcers are the most common lesions and are always multiple, as many as twelve or more being recorded. The surrounding mucosa is usually hyperæmic, the vessels being tortuous and prominent.

In the tertiary stage the lesions are of two types: the gummatous ulcer, and the papillomatous tumor; these two lesions may coexist. The ulcers are usually single, with ragged, infiltrated margins, grayish bases, and surrounded by a zone of deep red color. There is increased vascularity of the mucous membrane, and the vessels are very tortuous and distended. In some cases, however, the entire surface may be swollen, smooth, and glistening, and the vessels hidden.

The papillomatous tumors may be small or large, smooth or very irregular, and may resemble somewhat either carcinoma or the ordinary benign tumor. Their surfaces are frequently ulcerated, and may be covered with incrustations.

The most common site for both the secondary and tertiary lesions is on the base of the bladder just external to the ureters; but they may be found on any part of the bladder-wall. In the male the gummatous tumor situated near the internal sphincter may suggest an intravesical projection of a lobe of the prostate. It is also common to find the vesical orifice in females greatly swollen and irregular, or to find a gummatous tumor in this region. The tertiary lesions show no tendency to spontaneous cicatrization, but tend to progress, invading the bladder more and more deeply until perforation occurs.

Syphilis has been called the great imitator, producing symptoms and lesions closely resembling those of many other diseases. However, a diagnosis, based upon the elimination of other common possibilities, a strongly positive Wassermann reaction tested by a reliable pathologist, and the disappearance of all symptoms and lesions with antisyphilitic treatment, may be rightly accepted. Conclusions based upon these premises convinces the author of the merit of the following case:

Miss F., age 19. On November 25, 1912, came in complaining of pain in the bladder and painful frequent micturition.

*Family history* was negative, no tuberculosis; no deaths in the family except two from accident. The mother never had any miscarriages.

*Personal history.* Has always enjoyed good health, and never had any serious illness; no renal colic or urinary trouble until the present illness. Denies venereal disease, and has had none of the

usual symptoms of secondary syphilis. Menstruation began at the age of 16, and has been regular every twenty-eight days, and always painless: no excessive flow at any time. Habits are temperate: but admits frequent sexual indiscretion, the first time one year ago (which statement might rightly be modified).

*Present illness* began three years ago as a burning at the neck of the bladder, and some increased frequency of micturition. This was slight at first, but gradually increased until she sought relief, and was treated at intervals for cystitis. She now voids every half hour during the day and five or six times at night, sometimes with considerable tenesmus. There has been no incontinence, but urgency is marked. The pain at the neck of the bladder is relieved for a few minutes after voiding, but soon recurs, increasing in intensity. Micturition is very painful, and sometimes there is a little delay, some straining being required to start the flow. The pain in the bladder is described as a pressure over the organ and a burning at the neck, with some pain occasionally to one or the other side of the suprapubic region.

There has never been any hæmaturia, but she thinks that the urine is a little cloudy at times. No pain in the back, or over the kidneys, or in the legs. No chills or fever, and no loss of weight. Menstruation has been regular and painless, and the bladder symptoms are very little increased at this time.

On examination, the patient appears healthy, well nourished, and of good color. Chest and abdomen are negative, except a little tenderness over the bladder. No enlarged lymph-nodes.

*Vaginal examination.* The vulva appears normal, the hymen ruptured. No ulcerations or scars are to be seen, and there is no discharge from the urethra. Bartholin's glands are not palpable. The uterus and adnexa are in normal position and normal size, and are not especially tender. There is a slight discharge from the cervix, which shows a few pus-cells, and many gram-negative bacilli, but no diplococci.

Urine obtained with a catheter is clear, and contains no pus-cells, but a few red blood-cells and some pavement epithelium. No bacteria. Cystoscopy was attempted, but as soon as 50 cubic centimeters of water had been forced into the bladder the pain was so great that the examination was impossible. The patient was not seen again until April 25, 1915: under anæsthesia she had been cystoscoped twice in the meantime, but had had no treatment. The symptoms are of the same character as before, except that she has to void every ten minutes day and night, and has thus been confined to the house for some time. There has not been any hæmaturia whatever.

*Examination.* The urine obtained with a catheter is the same as before. The urethra was anæsthetized with 10 per cent novocaine. The bladder holds 50 cubic centimeters of water with difficulty. The scope enters with ease, no obstruction being encountered. The vesical mucosa is seen to be, everywhere, of a very deep red color, and is smooth and glistening. The blood-vessels are not to be seen, the ureteral orifices are normal, and clear urine is seen to escape at normal intervals. The bladder-wall is not trabeculated. The vesical orifice is quite swollen, especially at the left anterolateral portion, and is here covered with a livid colored mucous membrane. There are no ulcerations.

Vaginal examination afterward was negative, except that the bladder felt thick on bimanual palpation and was very tender.

Careful examination was then made for gonococci, but none was found. During the next two weeks the bladder was treated every two or three days by instillations of argyrol 10 per cent with no result. On May 13, a small, slightly elevated, soft red spot was noticed on the left labium major. Syphilis was then suspected, and the patient was given mixed treatment, mercury and potassium iodide, in strong doses, and at the same time referred to the laboratory for a Wassermann, which she failed to carry out. The antisyphilitic treatment was pushed until June 18, when it had to be stopped because of salivation. She had also had the bladder distended by hydraulic pressure every three to five days during the same period, but it was exceedingly painful, caused bleeding, and the capacity never exceeded 210 cubic centimeters.

However, she was much better, voiding every hour during the day, and not more than five times at night. The burning and pain had all disappeared. During the next six months attempts were made every seven to ten days to increase the capacity of the bladder by hydraulic pressure, but it was always very painful, and never admitted more than 230 cubic centimeters. On November 1, the bladder was more irritable: cystoscopy showed the vesical mucosa more normal in color, with only a few hyperæmic patches. The vesical orifice was still swollen, and the mucosa here of a livid color. The urethral mucosa was deeply congested, and bled readily, but no ulcers were to be seen. A ten per cent silver nitrate solution was painted over the urethra and vesical neck, and this treatment repeated several times during the next month, with some temporary relief.

On April 1, 1916, she returned for observation. She was voiding without pain every two hours during the day and three times at night. On the right labium was seen a small annular eruption, typical of an annular syphilid, and just above it was a small flat papule similar to the one seen on the opposite side a year before. A Wassermann test was made at once, and found to be strongly positive. During the next four weeks the patient received four injections of arsenobenzol, 0.4 gram, and mixed treatment in addition.

At the end of this time she was voiding every three hours during the day, and not over twice at night, and all pain and discomfort in the bladder

were gone. The bladder examined on May 24, showed a normal mucosa everywhere, except at the vesical orifice, where, on the left anterolateral portion, it was still a little swollen, and the mucosa deep red. The bladder held 250 cubic centimeters with only moderate discomfort, but is evidently considerably contracted.

Mercurial treatment has been advised for some time to come.

This report concerns a patient aged 22, when she sought treatment; she had suffered with the symptoms of a severe chronic cystitis for five years, with no period of relief; there was never any visible hæmaturia; there was no history of venereal infection, or of the usual manifestations of secondary syphilis, but she admitted frequent exposure.

The diagnosis of syphilis of the bladder was made only after the appearance of a suggestive syphilitic eruption on the labia, the extremely irritable condition of the bladder, and its contracted condition, and the very deep hyperæmia of the vesical mucosa, which was swollen, smooth, and glossy; and, finally, the presence of a strongly positive Wassermann reaction, and the marked improvement after antisyphilitic treatment.

In regard to the differential diagnosis, repeated tests for diplococci were negative even after dilating the urethra, and the application to the urethral mucosa of strong silver nitrate solution.

There is a type of chronic urethritis in women which is characterized by the symptoms of a chronic cystitis, clear urine with only a few or no pus-cells microscopically, no urethral discharge, and a hyperæmia of the urethra and trigone of variable degree. This condition has been well described recently by Shallenberger, in the *Journal of the American Medical Association* April 1, 1916. These cases are relieved after a few applications to the urethra. The author's case was thought at first to be of this nature.

Kelly (36) describes a condition of "hyperæmia of the bladder" usually patchy or limited to the trigone, and associated with considerable urinary distress. He states that "the causes of this condition are sometimes difficult to determine. I find it in all those cases which have hitherto been diagnosed as 'irritable bladder,' 'a teasing of the neck of the bladder from retroflexion of the uterus,' or 'pressure of an anteflexed uterus on the bladder,' or 'neuralgia of the bladder'; it is also the only lesion existing in many cases under treatment for a supposed cystitis." The trigone sometimes has a puffy or œdematous appearance.

In the author's case the uterus and adnexa were in normal position, and there were no evidences of adhesions about the bladder. There was no stricture of the urethra, and no ulcers on the mucosa. There was no evidence of cord lesion. The ureters were catheterized early, and no obstruction found; and the renal function on both sides was excellent. Roentgenographs showed no calculi. Tubercle bacilli were also diligently looked for without result.

Syphilis of the bladder is seen more commonly in the tertiary stage, the lesions consisting of ulcers, tumors, or both; but in the late secondary stage, and in the tertiary stage, hyperæmia, either diffuse or in patches, is constant.

This case is unusual because of the absence of hæmaturia, and because of the long duration of the disease without ulceration or definite tumor formation, unless the marked swelling at the vesical orifice was a gumma.

The absence of ulcers, vegetations, etc., should not rule against the diagnosis of syphilis. Excessive swelling and hyperæmia of the vesical mucosa, either diffuse or patchy, associated with the symptoms of a cystitis unresponsive to local treatment, the absence of all common etiological factors, and especially the absence of infection in the urine, the presence of a positive Wassermann reaction, and the prompt disappearance of all symptoms and lesions after antisyphilitic treatment, should constitute sufficient evidence upon which to base a diagnosis of syphilis.

In conclusion it should be emphasized that primary cystitis is very rare; that the most careful search should be made for one or more of the various causes in all cases of vesical irritability; and finally, in cases of obscure origin, especially those associated with sterile urine, and marked hyperæmia of the vesical mucosa, a Wassermann test should be made, and if positive, antisyphilitic treatment should be the only medication used.

One should bear in mind, also, that painless hæmaturia of sudden onset may be due to a well developed tertiary lesion, and in all such cases cystoscopy should be insisted upon. Lastly, in patients presenting tumors of the bladder, and who give a history of syphilis,

the specific nature of the neoplasm must be suspected.

As more attention is given to syphilis as a cause of certain urinary disturbances, no doubt more cases will be reported, and further contributions on the subject would be of great general interest.

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# THE SURGERY OF BRONCHIECTASIS

## Including a Report of Five Complete Resections of the Lower Lobe of the Lung, with One Death[1]

By SAMUEL ROBINSON, M.D., F.A.C.S., Rochester, Minnesota

BRONCHIECTASIS is a chronic loathsome disease—generally regarded as incurable. The expectoration is disgustingly profuse; consequently the afflicted loses employment, shuns society, becomes a recluse and not infrequently resorts to dissipation. He is pale and a trifle cyanotic. His fingers and toes are clubbed. He labors with early fatigue. He coughs spasmodically with varying persistency. Stooping, laughing, eating, hurrying, flood his trachea with pus and he retires, embarrassed, to drain himself of abundant sputum. In winter he is periodically ill with severe "colds," sometimes with bronchopneumonia, nor does the mildness of summer rid him of chronic cough. He may live many years till cerebral abscess, pneumonia, septicæmia, amyloid disease, or hæmorrhage happily ends his existence.

A patient with a certain type of bronchiectasis is apt to remark: "I have coughed all my life, ever since I had measles (or whooping cough) when I was small." He may say: "They say I had typhoid pneumonia when I was four" or "ten years ago I had the grippe and I've coughed ever since." It is probable that bronchopneumonia incident to such infections as the above constitutes the pathology from which develops the chronic state of bronchiectasis.

A foreign body (Fig. 6) may produce bronchial ectases, again possibly through the interposition of bronchopneumonia.

Bronchitis, unrelieved, may be attended eventually by dilatation of the tubes.

Chronic abscess of the lung associated with a chronic pneumonic lung lobe will develop a condition in which some dilatation may be present. The term "bronchiectasis" is frequently applied to such a state.

Fœtal bronchiectasis is described as originating in lungs remaining atelectatic from birth.

Chronic pleurisy, chronic empyema, and chronic non-tuberculous lung infections are sometimes forerunners to ectases of the bronchi and bronchioles. This relation, however, is uncommon.

Tuberculosis rarely accompanies bronchiectasis. When both are present, the upper lobe is generally the one involved, a fact which would indicate that the tuberculous process is primary and the bronchiectasis a later development (McCrae and Funk).

Tracheobronchial lymph-glands may enlarge sufficiently to partially obstruct a bronchus; likewise tumors of the mediastinum and lung. Chronic bronchopneumonia may then be followed by bronchiectasis.

Syphilis may be a cause or at least an accompaniment. Positive Wassermanns are not infrequent in patients with bronchiectasis.

Unfortunately, because of its derivation, the term "bronchiectasis" may be applied to any bronchial dilatation whether the latter be an incidental development or the underlying disease. As the clinical picture, the radiograph, and the pathologic specimen vary materially in the different types of the disease, it is to be hoped we shall employ eventually more specific nomenclature to differentiate the several groups.

It is quite obvious from the specimens shown in Figs. 1, 2, 3, 4, 5, and 6 that the material forming the basis of this paper represents the exaggerated type of the disease.

It is absurd to regard the mere mechanical effect of coughing as the cause of bronchial dilatation of this idiopathic type. The bronchial mucosa becomes infected and inflammation extends thence into the bronchial wall. We are necessarily ignorant of the pathology of this early stage when a bronchitis is becoming a bronchiectasis. If the usual primary bronchopneumonia has been survived, the patient lives on at least until the complete pathologic picture of the

[1]Presented before the Johns Hopkins Medical Society, December 4, 1916.

advanced disease is provided at autopsy or by lobe resection. Then we find cylindrical ectases of the tubes, saccular aneurism-like dilatations of the walls, sclerosis of the lung parenchyma, and cord-like pleural adhesions. The lumen epithelium is cuboidal, the elastic fibers are scattered and disconnected, the cartilages may be degenerated, the submucous vessels are dilated, and the adventitia has become a thick, fibrous, unyielding layer. We must assume for the present that the bronchial wall loses its tone from infiltrating infection. The diseased mucosa fills the lumen with purulent secretion, the expulsion of which by coughing forces the already weakened bronchial wall to dilate. The subsequent sclerosis of the peribronchial and interalveolar tissue may then by contraction drag the bronchial walls apart and still further pronounce the ectasis.[1]

I must omit here the details of diagnosis. The stethoscope contributes little; the sputum findings are by no means conclusive. The history, however, is most significant and the X-ray, to say the least, confirmative. When clinically the case is probably one of bronchiectasis the X-ray rarely fails to reveal both its presence and its distribution (Figs. 7, 8, 9, 10 and 11). When, however, in the beginning, differentiation between chronic bronchitis and bronchiectasis is difficult, the roentgenologist is likewise doubtful. Furthermore, in cases of advanced and extensive ectasis with fibrosis the radiogram shadow may be homogeneously opaque (Fig. 10A), atypical and, therefore, not distinguishable from that produced by various other lesions.

### EXPECTANT TREATMENT

The internists' treatment of this disease has consisted in hygiene, climatic influence, vaccines, postural drainage, medicated inhalations and intratracheal injections. I have reviewed carefully the history of such therapies from the period of enthusiasm in England for creosote to the more recent claims for serum treatment. I find no evidence either in history or personal experience to dissuade me from the conviction that all non-surgical methods of treatment have failed to provide more than symptomatic relief of brief duration.

### COLLAPSE THERAPY

This method of treatment is mentioned solely to emphasize its uselessness. It is not strange that the technical development of methods of collapsing the lung resulted in their employment in bronchiectasis. It would seem—and it is yet difficult to convince some surgeons to the contrary—that forcing the collapse of a bronchiectatic lobe would obliterate the dilatation and sacculations, arrest secretion, and eventually heal the diseased portions. Ribs have, therefore, been resected to cave in the chest-wall over the infected area. Nitrogen gas has been injected (artificial pneumothorax) to produce lung collapse. An operative pneumothorax has been instituted and the lower lobe separated from its adhesions, thus facilitating the shrinkage. Gauze packs have been placed within the pleural cavity actually squeezing the bronchiectatic lobes. Extrapleural compression has been employed (Tuffier) to force the parietal pleura against the lung.

All these methods have failed to cure. No manner of compression is adequate to collapse the thick-walled, dilated bronchioles. The effect is as unproductive as would be the pressure of a sponge on a multitude of pipe stems. The total lung volume is unquestionably diminished; the gross secretion is perceptibly reduced; and the patient is temporarily encouraged but he is chagrined to find his permanent betterment trivial after being subjected to an operation of some gravity.

We are forced to conclude, therefore, that collapse therapy—though of unquestionable value in certain types of pulmonary tuberculosis—is useless in cases of bronchiectasis.

### LIGATION OF THE PULMONARY ARTERY

When the pulmonary arterial blood supply to a lobe of the lung is obstructed (Sauerbruch-Bruns), a shrinkage ensues. Microscopically the interalveolar spaces are found to be occupied by an overgrowth of connective tissue resembling a fibrosis. The alveoli are

[1] A paper based on the study of the gross and microscopic pathology of bronchiectasis by Robinson and Wilson will appear shortly.

consequently compressed and cease to functionate.

It was surmised from these experimental findings that such an operation might be curative in bronchiectasis. Again we are skeptical as to the future of this therapy in the type of bronchiectasis with which this paper deals. The pathologic changes are too far advanced to be rendered symptomless by arterial ligation. If applied in the incipient stage such therapy might well be of definite value.

### PNEUMOTOMY—DRAINAGE OPERATION

It might appear to be an oversight were pneumotomy omitted in this discussion; nevertheless, it is not entitled to a place in the therapy of bronchiectasis. Drainage is yet persistently attempted because of the traditional confusion between bronchiectasis and abscess of the lung; also because of the prevailing conviction, often difficult to overcome, that a pint of sputum must represent a large abscess cavity. Abundant sputum may come from cylindrically dilated bronchioles, presenting not even minute cavitations; it may arise from twenty or thirty sacculations not larger than a lima bean (Figs. 4 and 5); or it may be expelled from three or four cavities each 3 to 4 centimeters in diameter. Obviously the drainage of such cavities must be of little avail because of the immediate proximity of others. Bronchiectatic cavities are rarely confluent; the surgical opening of one does not necessarily mean the drainage of several. Yet one may read of patients cured by such operation—many isolated cases and sometimes groups of two or three. Careful analysis of these provokes suspicion that the operator may have been dealing with abscess rather than true bronchiectasis and one is often left in a quandary as to the late results. Mosler collected the reports of 19 cases and though eager to prove that a drainage operation is curative, his interpretation is open to dispute.

A true conception of the pathologic anatomy of bronchiectasis will not permit of any faith in the effectiveness of drainage operations. I have attempted this in three cases with direful results; autopsy only exposed the absurdity of my plan of attack (Figs. 4, 5, and 6). It is in the advanced septic cases with involvement of most of one lung and in which excision is out of the question that one is tempted to drain in the hope of relieving toxæmia. To enter the lung and "strike pus" seems at the moment gratifying. However, wound drainage as compared to mouth drainage is absurdly trifling. The patient's equilibrium, despite chronic sepsis, is upset. A negative phase is apt to follow, to which both heart and kidneys may succumb. Hæmorrhage, slow but constant, is not an uncommon sequel which is apt to defy attempts at control.

### PNEUMECTOMY

I believe that there is but one curative treatment of true bronchiectasis—excision of the diseased lung tissue. The group of suitable cases, however, is small. A young adult with a basal process confined to one lower lobe, with profuse sputum, offensive but not fetid; with slight, if any, rise in temperature; with loss of weight but without emaciation; with a normal heart and properly functionating kidneys—this is the type of individual in whom lung resection, properly executed, is attended with good chance of cure. It matters little whether the disease is of the cylindrical, ampullary, or large-cavity type, provided the general condition of the individual is as specified. Not more than one in every ten cases of bronchiectasis entering a hospital clinic represents this favorable type. The remaining nine are unsuitable; one may be a rachitic child with low resistance; several may have extensive involvement of both lungs; another, a local process in an inaccessible part of the upper lobe; another, nephritis; and the remainder may be poor surgical risks because of extensive peribronchial disease, secondary infection, and gross cavitation.

As time goes on the definition of a suitable case for excision will be less specific. Childhood, and even infancy, may be excluded from the contraindications. In cases in which the disease involves both bases, it is not impossible that excision may be performed on one side and subsequently on the other. Moreover, eventually the technique may be so

abbreviated that even septic individuals with complications may be regarded as suitable risks.

### LUNG-LOBE RESECTION

The problem as to the necessity of dividing lung-lobe resection into two or more stages may long remain unsettled. The successes in animal experimentation are perhaps misleading. The removal of a lung lobe from the normal dog in one clean operation without drainage is simple to the extreme. The insult to respiration and pulmonary circulation during operation is obviated by apparatus. The tight primary closure of the chest prevents postoperative disturbances in the remaining lung function and in the heart action. Lung infection is not a danger.

In man with diseased lungs and pleura, the same one-stage lobe resection has often been attempted. The mortality is at least 90 per cent. The operation itself is generally withstood with and without apparatus, but difficulties are apt to arise within twelve hours. The remaining lung functionates badly. The air exchange is insufficient. A "fluttering mediastinum" may be responsible, though probably not. The pulmonary circulation is upset; the right heart is overworked; toxines are absorbed; death may follow; and vaguely we conclude that the alveolar carbon dioxide content has been increased for lack of proper breathing, and the oxygen content of the blood lowered for lack of proper capillary circulation in the lungs. Be this pathologic complex what it may, it is now a familiar and gruesome picture in thoracic surgery.[1]

The fact that an occasional success has attended this one-stage lobe resection in man is not an argument that it should yet become the chosen method. It were better first to produce thoracic pathology in animals and study methods of overcoming it.[2]

At present writing it appears to be safer and saner to divide lobe-resection operations into more than one stage. The thoracic cavity seems to prefer gradually to accustom itself to new conditions. The history of successful lobe amputation is instructive. Until recently excision accidentally occurred as the final operation of a series. Those preceding were performed for drainage of a supposed abscess. The lung was contracted; a subsequent empyema had been drained. "Plastics" for cure of the empyema had produced chest-wall collapse. The lung disease having meanwhile continued, a shrunken lobe was "cut away" as a final exploit. Thus have been recorded lobe amputations which were never intended when the preliminaries were performed. Nor did the operators realize perhaps that the preliminaries were responsible for the success of the amputation.

Probably the secret of success in the several-stage method lies in the fact that almost any operation on the thorax which opens or even exposes the pleura over a considerable area, results in the formation of adhesions. When the pleura is opened in bronchiectasis, the diseased lobe invariably is found adherent to the diaphragm, pericardium, and basal parietes. If, before such adhesions are entirely separated, an interval of time is allowed before the lobe is amputated the normal lung tissue may be made to adhere. The mediastinum thickens and becomes less mobile. The diaphragm takes a new and higher position. The chest wall contracts. The lung of the sound side learns of its vicarious duties. The pulmonary circulation gradually adapts itself to a less inflated and less mobile lung and becomes accustomed to the gradual loss of the negative intrathoracic pressure upon which it physiologically leans.

With these adjustments first accomplished, subsequent amputation becomes less a disturber of the peace.

### LOWER LOBE RESECTION (TWO-THREE-STAGE)

#### FIRST STAGE

Immediately before entering the operating room the patient should lie for an hour on a bed the foot of which is elevated. Coughing is then aggravated by the secretions which gravitate to the trachea, and the bronchial tree is at least partially emptied. Ether should be given by the drop method. An amount adequate to keep the patient in

[1] It should be emphasized that the dangers associated with a one-stage lobe resection are by no means equally threatening in excisions of a portion of a lobe. Such excisions may be done in one stage.

[2] A paper entitled "Experimental Bronchiectasis," by Samuel Robinson and Frank C. Mann, will appear in the John's Hopkins Bulletin.

position is unfortunately sufficient also to lessen bronchial reflexes, and to prevent coughing. Thus is permitted the accumulation, at and above the bronchial bifurcation, of the ever-present profuse bronchial secretion. Marked cyanosis results and persists. At frequent intervals the anæsthesia should be "light" enough to awaken a cough, which alone, without expectoration, will clear the bifurcation sufficiently to admit air to the sound lung. In this manner the cyanosis may be lessened. At best, the appearance of the patient is bad, such as in most operations would be attended with other alarming symptoms.

*Tracheobronchial aspiration.* On three occasions I have introduced the tracheal tube and have applied suction to it intermittently with a motor-driven aspirating outfit. Ether, given as usual with the mask, is inhaled around the tube. This suction mechanism disposes of much secretion and modifies the cyanosis. If one cannot promptly perform intratracheal intubation, the tube may be put through the nose to the pharynx from which the suction device will remove the pus which wells up from the trachea. This intrapharyngeal aspiration, however, fails to remove the flooding at the bifurcation where relief is most needed. The time used in providing for removal of secretion is well expended.

*Intratracheal insufflation-differential pressure.* I regard as superfluous the employment of artificial aids to respiration during the two-stage operation of lobectomy for bronchiectasis. Neither insufflation nor differential pressure was used in any of the five cases herein reported.

*Incision.* The incision is crescentic with its convexity downward (Fig. 12a); starting at the level of the fifth 2 inches from the vertebral column, it crosses the eighth rib in the scapular line and terminates at the level of the sixth rib in the mammary line.

The skin and fat are dissected upward from the muscle for an inch. Vessels are clamped and tied. The latissimus muscle fibers are separated vertically to admit long-bladed curved muscle clamps which are applied in series above and below in the direction of the sternum and again toward the vertebral end of the wound. The muscle fibers are then divided transversely between the clamps.

A wet "salt square" is then applied to the edge of the skin-and-muscle flap, the clamps being wrapped within it. The second assistant, standing by the patient's shoulder, retracts the flap and elevates the inferior angle of the scapula (Fig. 12). Meanwhile the intercostal branches entering the muscle are clamped and tied.

The field thus exposed should permit the subperiostal resection of the seventh, eighth, and ninth ribs from their angles to the anterior axillary line. The intercostal bundles are then ligated and removed (Fig. 12B).

Scapular retraction is omitted. The muscle clamps are all removed and a continuous locking catgut stitch is taken along the upper and lower cut muscle edges.

This stitch is solely for hæmostasis; the muscle ends are not stitched together. It is difficult to apply the locking hæmostatic stitch at the beginning before dividing the muscles.

The skin is now closed tight with figure-of-eight tension silkworm-gut sutures and a running horse-hair stitch.

A graded compression pad made of folded gauze is applied to support the area of chest-wall denuded of ribs. Three adhesive straps (2 inches in width) are placed to render the pad an effective buttress. The usual dressing is applied with more straps over-riding the sternum and spine.

While generally such an operation is not followed by symptoms of shock, considerable blood loss is inevitable and the patient is in no condition to bear the added insult of pleurotomy and handling of the lung.

Much has been accomplished, however, by this first stage. The thoracic window has been made ready to open. The chest-wall collapse necessary for the subsequent obliteration of the space left after amputation of the lower lobe is provided. Something has been learned of the individual's resistance to surgical trauma, of his tolerance of anæsthesia, and of the amount of flooding by tracheal

secretion that is to be managed in his particular case.

The sole danger after the first stage is undue retention of purulent secretion. Coughing is painful; the expulsion of sputum more so. The *vis e tergo* provided by the chest wall in expulsion coughing is reduced by the operative defect, though somewhat restored by the compression pad.

Postoperative treatment then should consist in: (1) moderation in the use of morphine lest coughing be unduly withheld; (2) such periodic postural therapy as may aid in drainage of the bronchial tree; (3) constant renewal or tightening of the compression pad and supporting straps; (4) early sitting posture; and (5) an abundance of fresh air.

### SECOND STAGE

The interval prior to the second stage should be approximately a week in length. The power of expelling sputum should have been restored; all trace of shock should have disappeared; and the temperature should approach "normal."

The anæsthesia, tracheobronchial aspiration and other preliminaries are established as before. The skin stitches are removed; the scapula and flaps retracted; and the pleura again inspected. It will be found that in the upper part of the exposed field there are new pleural adhesions anchoring the upper lobe. The lower lobe is still adherent at various places, now somewhat retracted and purple red in color. The pleura is opened wide at any point whether adherent or not. There will be no particular change in respiration or pulse.

The separating of adhesions necessary to deliver the lower lobe is generally irksome. It is the difficult part of the operation. The lower lobe is generally bound to the diaphragm and costodiaphragmatic angle by tough unyielding bands which may not yield under digital pressure (Fig. 13). If undue force is used in stripping, the lung surface will tear before the adhesion gives way. Some of these should be cut. It is well, therefore, to free the lobe first from all but its diaphragmatic attachments, so that if bleeding occurs during the separation of the latter a clamp may be applied temporarily in the region of the lobe hilus. The interlobar fissure does not always provide a simple cleavage, nor is it advisable to employ too much force in this region lest the light adhesions be parted which by now should be holding the upper or middle lobes to the parietes. The pericardial surface is least troublesome of all.

If at any time during this process of liberating the lung lobe disturbances in respiration occur, the U-shaped skin and muscle flap is promptly swung down to cover the pleural defect. It is jammed against the chest wall with the palm of the hand until towel clips are applied bringing the skin edges together for a temporary air-tight closure. The stimulating effect of this procedure is almost immediate. A slight negative pressure is restored to the operated chest during the inspiration; the upper lobe receives some air; the mediastinum is held in better position because of greater equality in the intrathoracic pressure of the two sides. Consequently the sound lung functionates better.[1]

In Cases 1, 2, and 4 it will be noted that the second stage was closed in the midst of this separating of cohesions. In Case 5, however, this performance was completed and amputation done at the same sitting. As one becomes familiar with the "lay of the land," the necessity of three stages is diminished and yet *to stop the operation at the middle of the second stage and to defer the completion of adhesion-stripping and amputation to a third stage is a conservative measure not to be regretted and one which in difficult cases, may save the patient from undue hæmorrhage, shock, and carbon dioxide poisoning.*[2]

It is not until one has worked in the open pleural cavity with his patient persistently cyanotic (a necessary condition in etherized bronchiectatic patients) that he will realize the consolation to be gained from the knowledge that the operation may be safely stopped at any moment in the second stage.

If, however, the second stage progresses favorably so that it may include amputation, at least one distinct advantage has been gained; namely, that the patient will then have been rendered practically sputum-free

[1] The necessity for such interruption I have experienced but once in a lobe-excision operation. The respiration once stimulated thus did not falter again (Case 4).

[2] The division into three stages was unquestionably responsible for the recovery in at least two of my earlier cases.

and the postoperative convalescence will not be complicated by the retention of purulent secretion—the expectoration of which is even more difficult after the incompleted second stage of the operation than after the first.

AMPUTATION

If there has been no occasion to close the second stage prior to the complete delivery of the lower lobe, amputation is promptly performed as follows: A long curved clamp is applied to the root and closed to the last notch. The lobe is then amputated at least a half-inch distal to the clamp. The veins, arteries and bronchi are then picked up separately and ligated with No. 2 chromic catgut. A mass ligature of kangaroo tendon or braided silk is then placed just proximal to the clamp and tied as the clamp is slowly released, the ligature being guided into the crushed area evacuated by the clamp. Not infrequently two clamps are necessary safely to include the whole stump. It is apparently an equally satisfactory method to leave the root clamps *in situ* and to remove them on the seventh day (Case 5, Fig. 14).

Either of these methods of amputation results invariably in subsequent leakage of the bronchial stump. The portion distal to the mass ligature or clamps sloughs away within a week or ten days leaving one, two, or three fistulous openings of small caliber. Experience will prove whether or not it is expedient to attempt any special technique for hermetically closing the bronchus at the time of amputation. The bronchus at the point of division is generally dilated; its walls are thick, tough, and unyielding. It is probably not amenable to such treatment as invagination and end suturing as has been successful in normal animals. If treatment of this kind were attempted it would necessitate the isolation of the bronchus from the vessels in the hilus, the individual double ligation of the vessels before their division, and the crushing, division, cauterization, invagination, and suturing of the bronchus. Neither the clamp nor mass ligation could be employed. In the present period of undeveloped surgery of the diseased lung it would seem more proper not to sacrifice time at the end of a critical operation by any finesse in the treatment of the bronchial stump, which in its pathologic condition would stubbornly resist any technique of closure.

The minute fistulæ consequent to the clamp and mass ligature technique in no way complicate the convalescence. The pleural space is rapidly obliterated, the fistulæ remaining the only unhealed points in the wound. By local plastic surgery under local anæsthesia the fistulæ are closed later by the superimposing of a skin-and-fat flap.

The after-treatment of the second operation is simple. Bronchial secretion is no longer a cause of anxiety. Within the first two days the bronchial tree becomes free from the residue emptied into it from the lower lobe just previous to its removal.

With return of consciousness the patient discovers that the promised reward of his long siege of treatment is now a reality. The sudden freedom from a cough of perhaps ten years' duration is a stimulus mentally and a boon physically.

The pack is not disturbed for four days, by which time it is foul. At least two-thirds of it can then be removed painlessly. When firmly adherent to the raw surfaces of the parietal pleura, fragments of the gauze should be left till they have sloughed away. Again precaution is taken at each dressing to repack the persisting pleural space completely lest pocketing occur in the costodiaphragmatic angle or about the pericardium or posteriorly below the lower limits of the neighboring lobe. At no time in the convalescence should drainage-tubes be substituted for gauze. The skin opening has been so designed that it will not close until the cavity is obliterated. Irrigation is never indicated. Granulations may be stimulated with balsam of Peru. The pleural space remaining after excision of the lower lobe having been already diminished by the shrinkage of fibrosis attendant upon the first two stages, may now be obliterated within four months. The patient meanwhile attains a body weight equal to his previous maximum and this continues to increase rapidly during the months following closure of the wound.

THE OPTIONAL INTERMEDIATE STAGE

If, in the course of separating the lower lobe from its adhesions during the usual second stage of lobectomy, indications arise for closing the operation before amputation, the whole procedure is converted into one of three stages. A gauze pack (6 inches wide; 8 thicknesses) is then "fed" into the unoccupied portions of the pleural cavity in such manner that the partly delivered lobe may not adhere again to the structures from which it has just been separated. Care should be taken that the entire costodiaphragmatic angle is packed—that the pericardial surface is protected; that loops of the pack are interposed between the lobe and the costal pleura; lastly, that any pleural pocket produced by retraction of the upper lobe be likewise filled with gauze. In placing the pack, care is taken to fill all the spaces and to do so with moderate pressure only. If a pleural area is overlooked adhesion bands may form subsequently and encapsulate a local empyema (Cases 2 and 5).

The lower lobe, shrunken by disease, is now also partially collapsed. It is surrounded and "jacked up" by the gauze pack in such fashion that there is some tension at its root. This adds stability to the mediastinum and also prevents undue retraction of the neighboring lobe.

The cavity, *filled with gauze, is closed tight without drainage.* The flap is sutured in place with interrupted figure-of-eight silkworm-gut sutures taking in skin and muscle. A running horse-hair stitch is added to hermetically close the wound. The dressing is applied with a graded compression pad and "adhesive," as after the first stage of the operation.

The gauze packing and the tight closure of the wound are important factors during the first two days of convalescence. They serve as a buttress to the healthy lung lobes as well as to the bronchiectatic lobe. Coughing is rendered effective in expulsion of secretions. The pack takes up any infection which may have escaped from the diseased lobe during its liberation and hastens the anchoring of the upper and middle lobes in their new position by adhesions.

During the first twenty-four hours, the wound and the gauze pack should not be disturbed lest a wide-open pneumothorax further restrict the efficacy of breathing, and the *vis e tergo* to expulsive coughing be sacrificed. Nevertheless, the onset of hydrothorax must be assumed and provided for just as soon as it is evident that the patient can dispose of his sputum despite the reopening of the wound and the loss of chest-wall support. This time arrives between the third and seventh days. It is well first to open a half-inch of the wound and allow the effusion, which will have overflooded the pack, slowly to leak out. This will relieve the patient of an intrathoracic tension which is painful and which must always be relieved before it becomes excessive. Gradually then, on the following day, the removal of the pack is started and finally completed in two subsequent daily sittings. When the pack is entirely removed it must be carefully replaced, a procedure which necessitates wide opening of the wound with retraction of its edges. A drop-light is essential for the inspection of the pleural space in order that every unoccupied portion may be refilled with gauze; otherwise an overlooked pleural pocket may produce a local empyema. Furthermore, new adhesions will form between the collapsed lobe and costal pleura at any point where the packing is not replaced. The dehydration coincident to the profuse secreting of the pleura becomes apparent in the patient's facies, causing a marked pallor which persists for several weeks.

One is astonished at the rapid obliteration of the new pleural space around the collapsed lobe. Although the discharge becomes purulent and the cavity to all appearances is an empyemic cavity, it lacks the proverbial stubbornness to obliteration of an empyemic cavity. On the contrary, the space is rapidly filled by elevation of the diaphragm, by partial mobilization of the mediastinum, and by "healthy" pleural granulations.

The management of the interval following the second stage in a three-stage lobectomy cannot be followed by rule or schedule. Certain dangers are to be obviated, certain steps are to be taken, but the indicated and oppor-

tune moment for each must depend upon the progress of the particular case in hand.

I am convinced now that in the three-stage lobectomies included in the case reports, an undue interval was permitted between the second and the third stages. Two to three weeks should be sufficient.

The third or amputation stage of the three-stage operation is no more nor less than the latter half of the second stage of the two-stage operation already described. The separating of adhesions is completed sufficiently to deliver the lower lobe which is then amputated.

### INTERCOSTAL LOBECTOMY

To open the thorax without the resection of ribs by the technique which Mikulicz and Sauerbruch first utilized in experimental surgery, is unquestionably the ideal method. The intercostal incision followed by rib spreading, together with the division of one or two ribs, permits a perfect exposure for any intrathoracic operation. Lobectomy through such an opening has been universally successful in animals. Lilienthal reports five complete lobectomies by the intercostal route in man, with two deaths. Certain other surgeons have had a 100 per cent mortality with the same technique.

One is instinctively loath to adopt a technique associated with high mortality in the hands of competent technicians, when a different technique, though infinitely more laborious, has resulted in but one death in five cases.

It is fallacious to argue that a person with bronchiectasis is too wretched to live and that a surgical death is a permissible hastening of his exitus. On the contrary such an individual should not be made the subject of great operative risk as in cases of malignant disease. As wretched as his existence may seem to others, the unfortunate afflicted with bronchiectasis would probably never submit to an intercostal one-stage lobectomy if he knew in advance the present mortality of such an operation. The 20 per cent mortality of the two-three-stage rib-resection lobectomy stamps it today as an operation which may be conscientiously advised. Nevertheless, be this as it may, the total number of recorded cases is yet too small to warrant the conclusion that the intercostal lobectomy may not yet become the operation of choice. It is conceivable that the eventually accepted technique may be a combination of the several stage advantages of the rib-resection lobectomy with the technical advantages of the intercostal lobectomy. Further experience may develop a method by which the intercostal technique may be combined with the two-stage idea in such fashion that the added simplicity of the former coupled with the protective physiologic effect of the latter may provide a method more ideal than either alone.

The technique of intercostal lobectomy is, therefore, herein described together with a discussion of methods of obviating some of its chief dangers, in order that this paper may not fail to mention an operation which in some modified form may become eventually the operation of choice.

### TECHNIQUE OF INTERCOSTAL LOBECTOMY

Some form of mechanical aid to the respiratory function is indicated in this particular type of operation. Intratracheal insufflation alternating at opportune moments with tracheobronchial aspiration may be used. The employment of differential pressure is particularly indicated in bronchiectasis cases because of the profuse secretions. However such apparatus is rarely available.

The incision follows the seventh or eighth intercostal spaces from the rib-angles to the costochondral articulation. The skin and fat are dissected away from the muscles for an inch above and below the incision. The muscles are divided the length of the incision; the vessels ligated. Both layers of intercostal muscles are cut a distance of 2 inches at the center of the wound, the parietal pleura being thus exposed. The pleura is then nicked, air being allowed to enter slowly as the opening is closed intermittently with the finger. As respiration adjusts itself to the open pneumothorax the intercostal muscles and pleura are divided to the ends of the wound, care being taken that the cut is made midway between the ribs to avoid injury to the intercostal vessels.

Again it is well to pause to note the effect of wide-open pneumothorax on the particular patient in hand. A rib spreader is introduced. If the ribs cannot be separated sufficiently to permit access to the diaphragmatic and pericardial regions, the seventh rib is divided at the anterior end of the incision; it may also be necessary similarly to divide the eighth rib. The lower lobe is then separated from the adjoining lobe, the diaphragm, costal pleura, and pericardium.

At the completion of this generally laborious task the patient's condition may be questionable. If the cyanosis is marked or the pulse of poor quality the rib spreader should be removed, the ribs pressed together and the skin edges apposed with clamps or towel clips. Even if such temporary closure is not air tight, the lung function is enhanced and the right heart is relieved. In the absence of response to such stimulation, it may be well to close the wound and postpone amputation.

If the patient's condition warrants proceeding, the lobe is ligated and amputated in the fashion described.

The spreader is removed and the wound closed promptly as follows: Pericostal sutures (Sauerbruch), previously prepared, of strong silk threaded in long, half-curved, slender, round needles are placed 1½ inches apart. The two adjoining ribs, intercostal muscles, and pleural edges are enclosed in these stitches. Each pair of suture ends is caught in a separate clamp.

These clamps are held aloft by an assistant in such a manner as to tighten the sutures and approximate the ribs as the surgeon ties. Previous to the tying of the end suture the assistant relaxes the tension and a closed clamp is wedged between the approximated ribs to permit the free in-and-out going of air. At the end of an expiratory movement (if no apparatus is being used) the clamp is suddenly withdrawn, the suture drawn taut and hastily tied.

When differential pressure is being employed, it is exaggerated at the final moment of closure. If an intratracheal insufflation is in action the outflow of air around the tube is obstructed momentarily at the end of respiration by bilateral compression of the trachea.

Each of these maneuvers tends to reduce the volume of air remaining in the opened half of the thoracic cavity and consequently to partially inflate the lung. In the first instance (without apparatus) the chest wall at the end of expiration collapses upon the lung. In the latter instance (when positive or negative pressure apparatus are in use), the lung is inflated at the moment of closure, the air thus being driven out of the cavity between the jaws of the opened clamp. In intratracheal insufflation a sudden obstruction to the air-outflow likewise inflates the lung.

When the last pericostal stitch has been tied by the method described, the divided chest-wall muscles are brought together with a running catgut stitch. As it is important that the muscle approximation should be made strong, it is well to interrupt the continuous stitch with ties at three points in its course. The skin is closed with a running silk stitch. The first few layers of gauze in the dressing should be held snugly to the wound by a strip of adhesive half encircling the thorax. The "closure in layers" tends to seal any leakage which may occur between the pericostal ligatures. Pressure to the dressing prevents hæmatomata which might separate the layers and destroy their hermetic sealing effect.

To restore the remaining lobes of the lung to a state of at least partial inflation at the end of the operation is to restore also part of their function — not because inflation, as such, is of value, but rather because inflation is visible evidence that the intrathoracic pressure, which was atmospheric during the operation, has been converted into a negative pressure at the close of operation. Without such negative pressure the lung of the operated side cannot functionate adequately.

Nor would the loss of the function of one lung alone be disastrous necessarily were it not for the fact that, in contrast to the normal negative intrapleural pressure of the sound side, the lack of negative pressure in the diseased cavity which prevents the inflation of the diseased lung also permits a slumping of the mediastinal partition toward the sound side at inspiration and thus prevents the filling of the otherwise undisturbed lung. At expiration the mediastinum balloons toward the wounded half of the thorax.

The sound lung, therefore, is not emptied of its gaseous waste product ($CO_2$).

Lilienthal applies a fixation ligation to the stump of the lobe. This is brought into the wound, drawn tight, and fixed.

The greater the oxygenating power of the lung the less hectic will be the first twelve hours after the operation. Hence the importance of primary tight closure of the chest even though its reopening be subsequently imperative.

Again stress is laid upon the maintenance of proper breathing because the circulatory equilibrium is definitely dependent upon it. Heart stimulants may appear to improve conditions, but when the respiratory compensation is broken, cardiac and circulatory disturbances must follow sooner or later.

The relation of pulmonary blood-pressure to lung inflation has been the subject of much dispute and some experimentation. The amounts of blood contained in an inflated lung and in a collapsed lung have been measured and compared. My own experimental conclusions in this regard have agreed with those of certain observers and differed from those of others. By means of a long cannula introduced through an opening in the internal jugular vein to the right auricle and between the tricuspid valve to the right ventricle I recorded the pulmonary blood-pressure. A cannula in the left carotid artery recorded simultaneously the general blood-pressure. The respiratory excursion also appeared on the kymograph tracing.

One pleural cavity was then opened. Both blood-pressures remained unchanged until the opening was enlarged, whereupon the lung collapse increased and the pulmonary blood-pressure declined. The fall in blood-pressure was synchronous with and proportionate to the onset of dyspnœa. As the respiratory embarrassment was overcome and the lung re-inflated by artificial means (positive pressure), the pulmonary blood-pressure returned to normal. Had the same experiment been performed with the use of intratracheal insufflation to restore the respiratory equilibrium, the blood-pressure would doubtless have returned similarly to normal. Insufflation will maintain oxygenation without inflation; from which we must infer that the fall in pulmonary blood-pressure incident to wide-open pneumothorax in a dog is not due to the lung collapse *per se* but rather to an extensive reduction in its function of oxygenation.

In other words, the quantity of blood in the collapsed lung, be it increased or decreased, probably has little to do with the changes in heart action following wide-open pneumothorax, provided the proper air exchange is maintained artificially. The slowing of the pulse and lowered pulmonary blood-pressure accompanying the dyspnœa associated with wide-open uncompensated pneumothorax may result from the stimulation of the cardiac inhibitory center by an excess of carbon dioxide. The actual relation of the circulatory to the respiratory functions in the presence of an open thorax is an unsettled problem in pathologic physiology.

### DRAINAGE IN ONE-STAGE LOBECTOMY

The bronchial stump is a source of infection. A suitable culture medium is provided by the hæmorrhagic effusion which collects in the pleural space after operation. There is necrotic tissue both in the bronchial stump and in the stumps of adhesion bands which were cut away during the liberation of the lobe. All factors favor the progress of pleural infection.

Nevertheless in the first 24 hours of convalescence the suction of the chest wall is imperative. To destroy this by the addition of an open drainage is to sacrifice one of the chief promoters of recovery. It is well, therefore, before closing the intercostal stitch to make a one-half inch incision in the posterior axillary line overlying the intercostal space which the intrathoracic guiding of the finger indicates as corresponding to the very bottom of the pleural space. An opening is then made from the incision through all the chest-wall tissues into the cavity. Through this a ¼-inch rubber tube is passed which projects 2 inches into the space. Two silkworm-gut stitches are taken to approximate the skin closely about the tube *which is corked or doubled over and tied or clamped*. The intercostal thoracic wound is then closed as described. A spigot, as it were, is thus constructed which may be opened with suction applied as occasion arises. If the lung collapse is later extreme, the intrathoracic pressure may be rendered negative by sucking the pleural air out by this tube; simultaneously such fluid as may be present will be withdrawn.

If untoward symptoms develop a few hours after operation, effective restoratives are often sought in vain. The combined circulatory and respiratory embarrassments are woefully unresponsive to stimulation. For labored breathing a sitting posture, fresh air,

and oxygen are helpful. For labored heart action, irregular and compressible pulse and low blood-pressure, caffeine, camphorated oil, digitalis, proctoclysis, and hypodermoclysis should be administered.

## CONCLUSIONS

1. Advanced bronchiectasis cannot be cured by medications, inhalations, intratracheal injections, intratracheal irrigations, climatotherapy or vaccines.

2. Collapse therapy produced either by nitrogen, artificial pneumothorax or by surgical measures is not curative.

3. Pulmonary arterial ligation is of more definite value as a preparation for lobectomy than as a curative measure *per se*.

4. Excision of the diseased portion of one lung is the only curative treatment of advanced bronchiectasis.

5. In the present status of the development of thoracic surgery, lung resections should be performed in a two or three-stage operation. The several-stage operation of the rib resection type has been attended in the writer's experience with a 20 per cent mortality.

6. The operation of intercostal lobectomy has distinct technical advantages. When performed in one stage, an undue risk of life is incurred. The physiologic advantages of the several-stage technique may yet be successfully combined with the technical advantages of the intercostal exposure.

## CASE REPORTS

CASE 1. (See *Annals of Surgery*, 1912, lv, 512. Included in this series by courtesy of the Massachusetts General Hospital). J. R. C., age 36; dredgeman. Lues nineteen years previously; two years of treatment. Cough for 2 years. Twenty months ago a period of dyspnœa. Sixteen months ago "took cold"; fever, chills, dyspnœa, night-sweats. Cough increasing in past 14 months, accompanied by thin purulent sputum. Fourteen months ago, 55 ounces of "fluid" aspirated from chest with some relief of dyspnœa.

December, 1908. Left chest: flatness; absence of fremitus and breath sounds from fifth to seventh ribs anteriorly and below the inferior scapular angle posteriorly. Right chest normal.

Weight 148 pounds; temperature 98.6°; pulse 90; leucocytes 12,000. Sputum greenish, mucopurulent. Influenza bacilli present; also a few pneumococci. Tubercle bacilli absent.

January 28, 1909. Pneumotomy. W. M. C., Lung grayish in color and of tough consistency. Section removed with considerable hæmorrhage. Pathologist's report: Lung tissue more or less solidified. Diagnosis: chronic bronchopneumonia.

May, 1909. Rib resection for drainage of empyema following pneumotomy.

October 18, 1909. Since last operation patient has had two exacerbations with high fever and leucocytosis. Discharge now profuse from empyema wound. General condition improved.

Lobectomy (S. R.). First stage: Anæsthesia, ether anæsthol, oxygen. A curved incision with its convexity upward to include the scars of previous operations and the drainage wound. Muscle and skin flap reflected downward; posterior ends of ribs previously excised removed sufficiently to admit the hand freely into the pleural cavity. Adhesions extensive, preventing any indications of embarrassed respiration. Both upper and lower lobes separated from the parietes with considerable difficulty and some bleeding. Adhesions in fissure between upper and lower lobes also broken up.

Although patient's condition was not alarming, it seemed advisable to complete excision of the lower lobe at a second-stage operation. The entire lung was packed away from the parietal pleura except at the apex with handkerchief gauze. The lower lobe appeared to be of firmer consistency than the upper, although the latter was firmer than normal. The patient recovered from the preliminary operation during the following thirteen days, in which time the original gauze packing was not disturbed.

November 1, 1909. Second stage: Anæsthetic, anæsthol, ether, and oxygen. Incision of last operation lengthened to 10 inches. More of eighth and ninth ribs removed, permitting free access to the entire lower half of the chest cavity. Removal of the gauze exposed the lower lobe free from adhesions. The lower lobe was then clamped 1½ inches from its root. Amputation performed distal to the clamp. The clamp then slipped from the unyielding lung tissues, permitting profuse hæmorrhage from several points in the stump together with leakage of air through exposed bronchi. The large vessels were clamped separately and a mass braided silk ligature applied around the root of the lower lobe. Patient's condition somewhat threatening. Large gauze pack placed in pleural cavity around amputation stump. Skin and muscle flap only partially replaced with through-and-through silk sutures.

Convalescence from second operation surprisingly good.

Fourth day after operation: Patient subjectively in better condition than for many months.

Eighth day after operation: Gauze removed without hæmorrhage, also silk stay suture. Tenth day: Patient out of doors in wheel chair; sleeping well. Seventeenth day: Wound cavity visible and clean with no sloughing; patient walking.

December 7, 1909. Evidences of bronchial leak-

age in the stump disclosed by whistling noise during coughing. Coughing since operation has been slight up to this time. No sputum.

June 23, 1911. During past year and a half, patient's general condition has been distinctly better than for the past four years. The skin flaps left unsutured have retracted into the exposed cavity and become adherent in better position than if they had been sutured to bridge the cavity. New skin has extended inward from the flaps sufficiently to cover the base of the cavity with the exception of two square inches, in the midst of which are four small bronchial fistulæ. Exploring these fistulæ with a probe causes a reflex spasm of coughing, during which the diaphragm from below and the mediastinum and the heart from within bulge prominently. There is a slight mucopurulent discharge from these fistulæ, but the reflex cough is not accompanied by sputum.

July 7, 1911. Plastic operation for closure of fistulæ only partially successful.

In 1913, four years after lobectomy, a report was received at the Massachusetts General Hospital that patient had died in New Brunswick, of pneumonia. The details of death were never obtained.

CASE 2. Cylindrical and saccular bronchiectasis of lower lobe (Figs. 1, 7, 16). H. S., No. 125410; age 24; waiter. Alcohol and tobacco used in excess. Lesion on penis eight months ago diagnosed by local physician as luetic. No history of "secondaries" obtained.

Cough of ten years' duration dating from an "abscess of the lung." At that time large quantities of pus were expectorated for six weeks. Following this patient in moderately good condition except for a slight cough. Four months ago cough became more aggravated accompanied by a recurrence of foul sputum. Some dyspnœa occurred at night which would be relieved by the evacuation of a half pint of pus. During past month slight fever and three to four sweats at night. Cough is constant during day with profuse expectoration. Has lost some weight. Examination of lungs by auscultation: Marked dullness, diminished fremitus, and diminished breath sounds at right base. "Signs of cavity." Many "squeaks" and rales heard over both sides of chest, most marked over right side and possibly originating entirely from it. Roentgenogram (stereoscopic): "Bronchiectasis on right with multiple cavities at right base" (Fig. 7). Wassermann reaction negative. Sputum examination, Gram stain: pneumococci, pus-cells. Micrococcus catarrhalis. Blood agar plates. Pneumococci. No influenza bacilli.

March 17, 1915. The right lower lobe was resected.

First stage: Five inches of the seventh, eighth, and ninth ribs resected. Pleura opened wide. Lower lobe freed from its adhesions. Diaphragm adhesions not resistant. In order to prevent complete lung collapse the anterior border of the diaphragmatic surface of the lower lobe was sutured to the upper border of the thoracic window. A gauze pack was then placed in those portions of the pleural cavity not occupied by the partly collapsed lung. The skin-and-muscle flap was sutured in place without drainage.

The patient was cyanotic both before and after the opening of the pleura and remained so until coughing reflexes returned and the secretions collected in the trachea were expelled.

Six days after operation the stitches were removed and the gauze pack withdrawn. It was soaked in serum some of which had escaped between the stitches. The lower lobe suture had held; accordingly its diaphragmatic surface was readily accessible through the wound. The gauze pack was renewed daily.

Two weeks after operation six openings were made with a clamp in the under surface of the lower lobe as it presented in the wound, in the hope that at least some purulent secretion might thus escape and reduce the quantity of sputum which was now difficult to "raise." A temporary discharge followed through the fistulæ thus produced but with no material relief to expectoration.

In the following two weeks a septic condition developed with fever, leucocytosis, loss of weight. Examination of the wound revealed nothing. Chest examination was unsatisfactory because of the peculiarly altered conditions in the right pleural cavity. The left lung, however, appeared to be normal. Pus was obviously present but there was no clue as to its location. Fortunately a new discharge from the anterior end of the wound disclosed a tract connecting with a walled-off portion of the pleural cavity adjacent to the mediastinum and pericardium.

April 16, 1915, under ether, localized empyema drained and packed. A prompt recuperation followed with gain in weight.

June 11, 1915. Lobectomy. Second stage: The skin and muscle flaps were dissected upward. The two ribs next above those previously resected were removed from angle to mammary line. The lower lobe was then freed from all adhesions including those to the parietes. The interlobar fissure was also spread open over one-half of its extent. The operation was then brought to a close by the introduction of two gauze packs with which the lobe was "jacked up" away from all surfaces from which it had now been freed.

The postponement of amputation in this case was not occasioned by any unfavorable change in the patient's condition. Nevertheless considerable time had been consumed and the fear that any accidental blood loss during an amputation might not be withstood, resulted in the decision to close the operation.

The recovery from this stage was uninterrupted. The amount of sputum diminished only one-third after two months of actual compression of the diseased lobes within the pack which was renewed daily.

(This observation did much to destroy my faith

Fig. 1. Case 2, No. 125410. Cylindrical bronchiectasis. Excised lower lobe. Recovery.

Fig. 2. Case 4, No. 154561. Cylindrical and saccular bronchiectasis. Excised lower lobe. Recovery.

in the curative effect of collapse therapy in advanced bronchiectasis.)

August 12, 1915. Lobectomy, amputation.

The original field of operation was again freely exposed. No further rib resection was necessary to permit ready access to the lobe hilus, which was clamped and ligated *en masse* with kangaroo tendon. After amputation of the lobe, the separate arterial, venous, and bronchial branches were ligated with catgut distal to the mass ligature. The emptied portion of the pleural cavity was then packed with gauze, and it was noted that the upper lobe was everywhere coherent to the parietes which fact precluded the possibility of any further concealed pleural infection. Within one week the lobe-strings sloughed away leaving two small fistulous openings. Within two weeks the cavity was "clean" and its walls granulating.

September, 1915. The diaphragm has rapidly elevated itself. Shrinkage of all the cavity diameters has occurred. The upper lobe has not contributed to the filling of the emptied pleural space. The wound is rapidly decreasing in size in all dimensions (Fig. 15).

January, 1915. Patient has been at home three months. He has gained 30 pounds in weight. He has had neither sputum nor cough for four months. The wound is healed except at a small area in the new epithelium where two open bronchial fistulæ persist. There is a very slight non-purulent discharge from these. These fistulæ do not seem to concern the patient sufficiently to cause him to return for their repair.

Fig. 3. Case 5, No. 173830. Cylindrical and saccular bronchiectasis. Excised lower lobe. Recovery.

Fig. 4. No. A132408. Saccular (ampullary) bronchiectasis. Autopsy specimen of entire left lung. Death followed drainage operation.

Fig. 5. No. 124560. Saccular bronchiectasis. Autopsy specimen of entire right lung. Death followed drainage operation.

December, 1916. Patient reports himself well and traveling with a show. He requests the ownership of the "lung in a bottle" that his demonstrations at the show may be even more profitable.

CASE 3. Chronic abscess of lung: bronchiectasis. Pneumonitis. Death resulted from encapsulated empyema. T. S., No. 130276, male; age 23; janitor. Patient had had no illnesses previous to seven months before admission at which time tonsillectomy was performed under general anæsthesia three days after an acute attack of tonsillitis. The following night coughing commenced with expectoration and throwing up of blood. Such bloody sputum continued for one week. During the following three months blood disappeared from the purulent sputum which continued in increasing quantities. For the past five months loss of strength persisted, with profuse expectoration in the early morning. Vomiting to a half pint in 24 hours. Sputum was generally brownish or gray.

Fig. 6. No. 169958. Cylindrical bronchiectasis following 3 year retention of a foreign body (incisor tooth) designated by arrow. Death followed drainage operation.

Upon admission to the Mayo Clinic the clinical diagnosis was "abscess of the lung." The sputum was negative for tubercle and influenza bacilli. Pneumococci, micrococcus catarrhalis, diplococcus crassus.

Roentgenologist's report: Marked increase in density over lower two-thirds of left chest; probably old abscess in the anterior portion. Considerable retraction of pleura.

May 14, 1915. Exploratory thoracotomy.

Four inches of the sixth, seventh and eighth ribs resected in the region of the inferior angle of the scapula. Pleura opened wide. Lower lobe of lung found to be adherent to the diaphragm and to the posterior distal pleura. Palpation of the lobe revealed no definite focus suggesting an abscess. It was assumed, therefore, that a chronic condition was present in which a pneumonitis had developed around abscesses or in association with bronchiectasis. The adhesions to the diaphragm were separated, and the anterior border of the diaphragmatic surface of the lower lobe was sutured to the upper border of the thoracotomy wound. A note dictated at the time of operation reads "thus exposing the under surface of the lower lobe

Fig. 7. No. 125410. Roentgenogram Case 2. Unilateral (right) basal cylindrical bronchiectasis. Type suitable for excision.

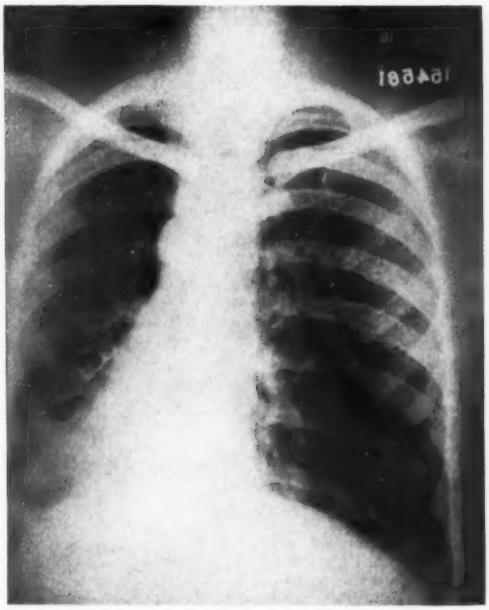

Fig. 8. No. 154561. Roentgenogram Case 4. Unilateral basal cylindrical and saccular bronchiectasis. Type suitable for excision.

for later exploration with instrument or cautery. Abscess left lung."

A large gauze pack was placed in the lower pleural cavity. The wound was closed tight. Subsequently I concluded that the necessary procedure in this case would be excision of the lower lobe, from which decision I must needs regard this preliminary operation as the first stage of lobectomy, though it was not intended as such.

The day after operation the pulse rose to 120 from which point it fell gradually in the course of the following fifteen days. The temperature was 102° on the seventh day, falling by lysis until the antemortem rise again to 102. The cough returned to its pre-operative state with the expectoration of green tenacious sputum. There was increasing loss of weight and strength. Finally dyspnœa developed. The gauze packs were changed daily after the third day. Death occurred the fifteenth day.

*Autopsy findings.* Moderate degree of cylindrical bronchiectasis. Large chronic abscess lower left lobe. *An acute left encapsulated empyema not connecting with the operative wound.* Acute purofibrinous plastic pericarditis with effusion.

Death occurred in Case 3 from septicæmia resulting from an unrecognized encapsulated empyema occupying a portion of the pleural cavity which was packed with gauze at the operation but which was not packed in the subsequent dressings. It is conspicuous that this accident occurred in three out of the five cases herein reported. In two of these the encapsulated area was searched for and discovered, thus saving the patients from similar deaths. *This untoward complication is emphasized as the most dangeorus sequel to the several-stage operation* — one nevertheless which, if not avoided by careful packing, may yet be overcome by detection and drainage.

Case 4. Saccular bronchiectasis of lower lobe and of basal portion of upper lobe (Figs. 2, 8, 17). B. L. P., No. 154561, male; age 20; clerk. Fourteen years previously patient inhaled one-half a plum stone. Four months later developed severe cough. Six months later "coughed up" the plum stone. Since that time (13 years) cough and expectoration of purulent material have persisted. Frequent colds. Occasional night sweats. Sputum rarely blood-streaked.

Physical findings. A pale and anæmic but fairly well nourished young adult. Fetid odor to breath.

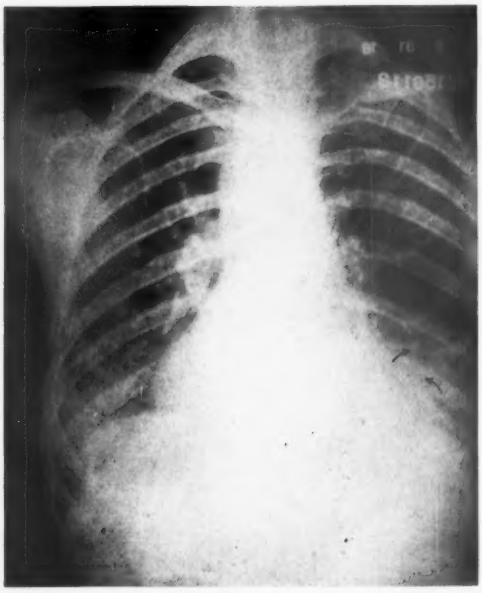

Fig. 9. No. 156113. Right lower lobe bronchiectasis, operable.

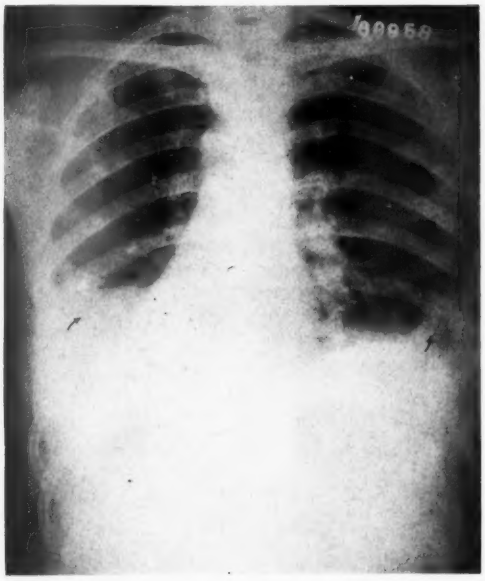

Fig. 10. No. 169958. Bilateral bronchiectasis, inoperable.

Fig. 10a. No. 124560. Roentgenogram: Advanced bronchiectasis with sclerosis. Cavities all obscured. Same case as Fig. 5.

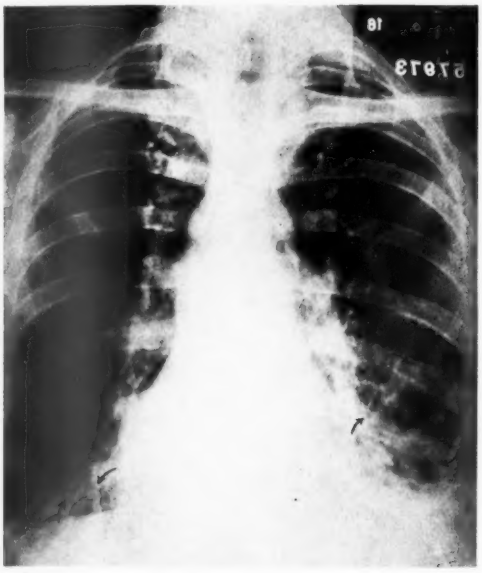

Fig. 11. No. 57973. Bilateral bronchiectasis, inoperable.

Fig. 12. Lower lobe excision in two stages. *a*, Crescentic incision; *b*, Stage 1, thoracic window made. Exposure of parietal pleura favors adhesion and anchorage of the upper lobe.

Relative dullness over entire left chest, particularly at lower portion. Numerous loud, squeaking rales at left base with areas of tubular breathing.

Leucocytosis 10,200. Urine negative. Roentgen findings: Marked thickening and cavitation left base. Thickened pleura at left base. Heart drawn to the left. Diagnosis: bronchiectasis.

Operation: left lobectomy, 3 stages. April 16. First stage: Ether anæsthesia; tracheobronchial aspiration. Seven inches of sixth, seventh, and eighth ribs resected in the inferior scapular region. Pleura opened accidentally during rib resection. Pneumothorax produced in upper portion of pleural cavity. Lung seen to be adherent below but not palpated. Skin-and-muscle flap restored with silk sutures. No pack. Patient cyanotic throughout operation, from secretions in trachea.

April 28. Second stage: Tracheobronchial aspiration. Original flap raised and lengthened. Six inches of two ribs above wound resected. Pleura reopened high where lung was not adherent. Pneumothorax caused no symptoms. Lung adherent to diaphragm and lower costal pleura. All adhesions separated except those to adjacent lobe and to pericardium. Gauze pack placed to fill all vacancies over which skin and muscle flaps were sutured for tight closure. Profuse serous discharge leaking between wound stitches on the third day. Temperature normal, pulse 120. Out of bed on fifth day.

May 16. Ether. Removal of pleural pack (two

Fig. 13. Lower lobe excision. Stage 2, thoracic window opened. Shrunken lower lobe is freed from its tenacious diaphragmatic adhesions.

weeks after its introduction). Skin stitches gaping; pack presenting. Gauze found soaked with serum but not pus and firmly adherent to pleural surfaces. Pack renewed.

May 24. Ether. Second renewal of pleural pack.

June 1 to August 4. Daily renewal of pack to pleural space which gradually reduced itself to size of a walnut.

August 5, 1916. Third stage of lobectomy. Original operative wound widely exposed necessitating removal of certain rib ends. Lower lobe rapidly delivered. Single large clamp applied to lobe root. Mass silk ligature applied proximal to clamp and drawn taut as clamp was removed. Vessels and bronchial branches ligated separately with catgut or silk. Large gauze pack placed in lower pleural space. The lower anterior portion of the upper lobe was noted to be of dark color resembling the bronchiectatic lower lobe. It did not seem to be a fitting occasion for further lobectomy and it was hoped that subsequent shrinkage might obliterate any process which might be present in the tongue of the upper lobe.

Bronchial leakage occurred with sloughing away of stump on seventh day. Through this fistula a purulent discharge was noted. There was complete absence of sputum except when a recumbent right lateral posture prevented fistulous drainage. Even then the sputum quantity never exceeded two ounces in 24 hours.

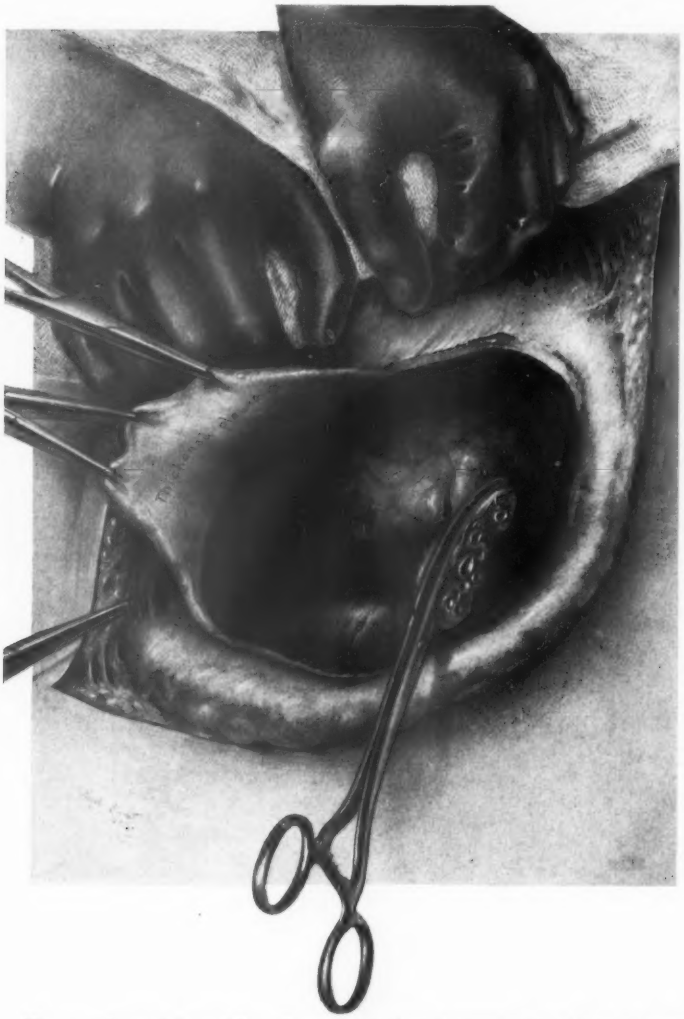

Fig. 14. Lower lobe excision. Stage 2, (continued), amputation of lobe. Clamp to be substituted by mass ligature. Additional ligatures to vessels in stump. Two clamps may be applied and left *in situ* without ligation.

December 25, 1916. The patient has regained his weight — he is no longer anæmic. The wound is healed except for a minute fistulous opening now surrounded by skin through which comes an offensive discharge. As long as this opening is patent there is absence of sputum. This man has now been advised to have a further resection of the diseased portion of the upper lobe in which disease is apparent in the roentgenogram. Comparison of this recent roentgenogram with that taken previous to the first operation, shows that the upper limit of the bronchiectatic cavitations has not changed proving that the upper lobe process was present in the beginning and has not since increased.

Case 5. Saccular bronchiectasis (Fig. 3). G. T., No. 173830, male; age 26; brakeman. Influenza 8 years ago. Five years ago began coughing. Sputum not excessive and occasionally blood-streaked. Sputum quantity gradually increased acquiring a foul odor until recently twice in a day he raised

Fig. 15. Case 1, Massachusetts General Hospital. Lower lobe excision; one year after operation.

Fig. 16. Case 2, No. 124510. Lower lobe excision. Two months after last operation. Pleural space not yet obliterated.

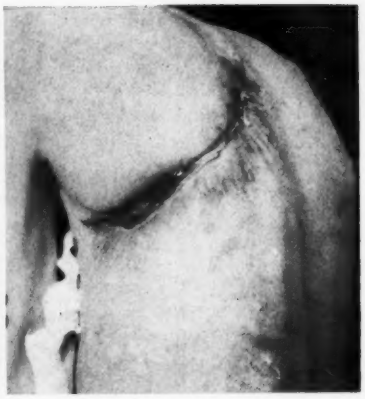

Fig. 17. Case 4. No. 154561. Lower lobe excision. Two months after operation.

half a cupful of yellowish fetid sputum with such force that it frequently discharged through the nose. No chills, sweats, or fever but frequent "colds."

Eight months previously a rib-resection operation performed over lower left chest by a Toronto surgeon. No relief resulted. Clinical diagnosis: bronchiectasis. Roentgen findings: retraction of ribs in costophrenic angle. Increased density resembling fluid. Bronchi apparently dilated. Case could be one of bronchiectasis.

Operation. Left lobectomy. Two-stage operation. October 9, 1916. First stage: Original area operated upon by Toronto surgeon exposed by elevation of a crescentic flap. Ends of four ribs resected further for 2 inches anteriorly and posteriorly. Pleura opened 1.5 inches during the separation of old operative adhesions. Lower lobe seen adherent to diaphragm. Part of interlobar fissure found open. Patient markedly cyanotic during whole operation. Pulse always good. Tracheobronchial aspiration not used. Skin and muscle flap sutured tightly in place.

Six days after operation difficulty in breathing developed together with sense of pressure in substernal region. There was fever and leukocytosis. Opening of the wound permitted the escape of some serum but the general septic condition was not altered. The fatal occurrence of an encapsulated empyema in Case 3 and the well nigh disastrous similar occurrence in Case 2 led to the suspicion that following the operative pneumothorax, the lung had not entirely re-expanded, that this unoccupied pleural space, probably in the upper thorax had filled with fluid, which being retained had become infected. A roentgenogram verified the suspicion, showing clearly an encapsulated hydropneumothorax at a higher level than the now open wound.

October 23, 1916, under ether, exploration for encapsulated fluid. Adhesions of left lower lobe to diaphragm separated without recover of fluid. Lower lobe then separated from outer wall permitting the escape from above downward of a quart of thin, semipurulent, foul-smelling fluid. A large gauze pack was introduced. The patient's condition promptly improved.

November 1, 1916. Second stage: Wound reopened. No further rib resection necessary. Parietal pleura now thickened ¼ of an inch. Lower lobe now exposed at the level of the diaphragm. The lobe was then freed from all attachments with more rapidity than in the previous cases. Unusual bleeding resulted, the source of which was not discernible until a clamp was placed upon the lobe hilus at which moment all bleeding stopped, exposing areas in the lobe lacerated during its delivery. Two more clamps were applied to the root for security — the experiment being tried for the first time of trusting to the clamp-crushing for hæmostasis and for at least the usual degree of bronchial closure. Therefore no ligatures were applied. A large gauze pack was carefully placed, it being noted meanwhile that the upper lobe had no parietal adhesions, because of the unfortunate occurrence of the localized pneumohydrothorax following the first stage operation.

The clamp handles were tied together with silk. Seven days after operation two clamps were removed. Two days later the third. The upper lobe lay almost completely collapsed against the posterior wall. A slight bronchial leakage became apparent on the tenth day, delivering a moderate amount of semipurulent secretion which has since gradually disappeared.

December 29, 1916. Patient discharged from the hospital. In two months following the lobe

amputation the patient has gradually regained strength though considerable septic absorption occurred during the "cleaning up" of the cavity from which sloughing fragments of visceral and parietal pleura have been thrown off. Today the entire cavity is clean, the parietal surface being covered with pink granulations. The visceral pleura is thin and free from exudate. There is no cough or sputum by day. At night a reflex cough is probably occasioned by the passage of air through a minute fistulous opening which lies under the overhanging border of the collapsed upper lobe.

The temperature is normal and the pulse steadily falling as the patient's general condition improves.

Within a few weeks a decortication of the visceral pleura of the upper lobe will be performed in order to restore its function and if possible to obliterate the now much shrunken pleural space.

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# ENORMOUS HERNIAS[1]

By WALTER R. HEWITT, M.D., St. Louis

UNDER this caption I have included only hernias of exceptional size and volume and presenting difficulties of the greatest magnitude. I am aware of the fact that smaller hernias, especially of the umbilical or ventral types occurring in obese individuals, frequently require the removal of a large area of skin and fat.

I do not propose to consider those hernias which are curable by removal of an abdominal tumor or cyst, followed by secure and proper closure, whether that be overlapping the layers, transplanting fascia or muscle, or the use of mechanical means, one or any combination of these.

You will, therefore, appreciate that these enormous hernias, chiefly of the inguinal or scrotal, and rarely of the femoral or labial variety, present a problem much more complicated in the technical details of the operations, often exceedingly difficult of execution, and with a very high mortality and morbidity as compared with the simple hernias.

In the class of hernias which we can designate as large or massive and below the enormous ones, the estimated death-rate has been placed at 6 per cent (McGlannan). However, when strangulation or obstruction is added the mortality in massive hernias reaches nearly 50 per cent and therefore we should expect a proportionate increase in those of the enormous type under similar conditions.

I propose to present two cases of enormous

[1] Read before the St. Louis Medical Society, May 20, 1916.

hernia: one inguinal and one femoral, both cases suffering from renal lesions in addition.

The average duration of confinement to a hospital in simple inguinal hernia has been placed at 18 days; after massive hernia, 48 days; and after enormous hernias 48 to 125 days and up. The causes of death in the enormous hernias fall into three groups:

1. Those due to cardiovascular-renal conditions: dilatation of the heart, apoplexy, uræmia, pulmonary œdema, embolism, and thrombosis.

2. Postoperative abdominal conditions: postoperative obstruction, acute dilatation of the stomach, peritonitis, and suppuration of the abdominal wall.

3. Those due to the strangulation: toxæmia of obstruction, peritonitis, from ruptured and gangrenous bowel, and embolism of the mesenteric arteries.

The early recognition and treatment of complications may avert the fatal outcome, whereas strangulation in enormous hernias and the free use of local anæsthesia or ether-oil-colonic anæsthesia (Lumbard) or spinal anæsthesia may avoid disaster.

It has long been recognized that acute cardiac dilatation is the most common fatal complication in non-strangulated large hernias and various explanations for its prevention have been urged.

Since, in large hernias, the patients carry a considerable portion of the abdominal viscera outside the normal habitat, there is a consequential loss of pressure on the large splanchnic vessels resulting in their dilatation and associated with compensatory changes in the general circulation which sustains the normal blood-pressure. This is still more striking in those of enormous size.

Now if to the above you have also added kidney insufficiency, which is a frequent complication, the burden on the heart is further increased.

In most cases of enormous hernia, one must deal with a chronic nephritis, associated with a vascular hypertension, and these add materially to the danger of cardiac exhaustion and dilatation when we superimpose an additional burden on the heart by the alteration of the abdominal pressure.

The return of the protruded viscera to the abdomen and tight closure of the hernial opening requires a readjustment of the circulatory balance and thereby throws a great burden on the heart muscle, which if weakened by a myocardial degeneration leads to a rapid and fatal dilatation. Should this burden be suddenly imposed, a fatal termination may soon be expected to follow.

The other complications are related as to cause to these two. Additional strain thrown upon an imperfect and unprepared cardiovascular system results in damage to the heart or vessels; and if to these we add the necessary increase of intra-abdominal pressure, coincident with reduction *en masse*, if this be possible, then an indication for colectomy becomes apparent. Jaundice, gastro-intestinal hæmorrhage, with or without ulceration, are abdominal complications due to the additional pressure, and may be avoided by removal of the whole or a part of the extra-abdominal mass. Careful pre-operative treatment, often extending over many days, is advisable, where possible, and will reduce the danger from such complications. This was possible in Case 1.

It is rare to find a patient suffering from an enormous hernia, who is free from some form of cardiovascular-renal disease and therefore a prolonged preparatory treatment is advisable. It is for this reason also that cases of voluminous hernia have not been advised to undergo surgical interference and the favorable time often passed.

If to the above, strangulation be added, a staggering mortality is only to be expected. Again, most enormous hernias are only partially reducible and the value of Johannes Hahn's treatment or modifications of it are limited and if we add hypersensitiveness, as in Case 2, it becomes still more confined.

However, bed rest, blood-pressure, and pulse readings and functional kidney tests (phthalein), when possible, are very valuable. A snugly applied binder, gradually tightened, with careful observations on the blood-pressure, heart action and respiration, may prove of some value, especially in enormous herniæ of the ventral or umbilical type. The 24-hour intake of fluids and the output of

urine during the same period should be recorded where this is possible.

Williams[1] states that laparotomy decreases the urinary excretion about two-thirds during the twenty-four hours immediately following and this statement coincides with my observations in voluminous hernias.

Tracy,[2] in speaking of "the phenolsulphonephthalein test from the abdominal surgeon's viewpoint," concludes that it does not seem possible to work out the minimum percentage phthalein output with which it will be safe to undertake surgical operations, nor is it possible from the phthalein test to determine what causes should or should not be subjected to operation, and he gives as his reason the variability of the kidney function under numerous circumstances and at different times. However, he believes that the test used in conjunction with the clinical symptoms, history, and physical examination is of value.

Preliminary treatment may last for several weeks depending upon the severity of the handicap. When there is obstruction or strangulation, immediate operation becomes imperative and if the patient is toxic a two-stage operation may be necessary.

As a rule, enterostomy with extrusion of the bowel above the point of obstruction is better than the resection and anastomosis where the toxæmia is marked. In large hernias, Hahn has advised a two-stage operation in the absence of toxæmia and obstruction. Ruge, in a study of the pathology and treatment of umbilical hernia, maintains that the proliferation of the properitoneal fat causes one or more defects in the anterior abdominal fascia through which the hernia protrudes, and, as the hernia enlarges, the recti are pushed apart with greater or less degeneration according to the extent of the separation, the duration of the lesion, and the general condition of the patient.

Trauma, especially violent exertion, during parturition, usually regarded as an accessory cause, by forcing the contents through an already existing defect, was found to be a factor in my case of the femoral type, where an actual tear of Poupart's ligament existed (see Case 2).

[1] Cæsarean Section. Interstate M. J., 1915, April.

[2] Surg., Gynec. & Obst., 1914, xix, 734.

### TREATMENT PROPER

Reduction of a large hernia *en masse*, especially in stout people, will dangerously limit the movements of the diaphragm and lead to engorgement of the heart and lungs. I have previously pointed out[3] the anatomical fact that "the margins of the central tendon of the diaphragm are prolonged onto the walls of inferior vena cava as it passes through the foramen venæ cavæ and therefore the contraction of the muscular fibers of the diaphragm will increase this opening and the caliber of the vein which it holds, while the aorta placed behind a fibrous arch is unaffected. Hence any interference in the free movement of diaphragm must, for the above reason, as well as by lessening the negative pressure or suction action, increase the engorgement. This is strengthened when we recall that the blood-pressure is not raised by artificial means at once, about 10 seconds being required before we can raise the blood-pressure 20 millimeters of mercury and probably due to the increase in breathing area.

Barker in speaking of *voluminous hernias* advised rest in bed, limited or restricted diet, and daily attempts to reduce the mass partly or wholly, and when these methods fail he rejects the patient as unfit for operation. He strongly recommends local and spinal anæsthesia in view of consecutive lung, liver, and kidney troubles and rarely operates under a general anæsthetic for hernia. You will therefore understand that colectomy, while a bold measure and not to be undertaken lightly, is a safer procedure in voluminous hernias than attempting to return into the abdomen a tangled mass with the chances of adhesions, obstructions and even perforation following, not to mention the embarassment to the respiratory and circulatory systems.

In nearly every case of enormous hernia, and this was evident in Case 2, colectomy, through necessity, becomes the operation we must undertake.

Briefly the colon is mobilized usually at

[3] Electric Accidents. J. Mo. St. M. Ass., 1913, Sept.

Fig. 1, Case 1.

the cæcum and then resected making preferably an end-to-lateral anastomosis of the ileum and sigmoid by suture — an ileosigmoidostomy. Lane now advocates an end-to-end anastomosis.

The restricted operation of Moynihan should be performed, when possible, on account of the better end-results.

Removal of a greater part of the omentum reduces the amount of mass to be returned and the consequential postoperative increase in tension. However, the removal of a large mass of omentum may so damage (by embolism) the circulation of the stomach wall that ulceration and hæmorrhage will follow, and this must be borne in mind. The usual incision for hernia of the particular type is indicated, though somewhat longer, the contents are exposed, reduced or resected, and the sac removed along with redundant tissue, ever remembering that the vitality of such tissue is usually low.

Some type of the Ferguson operation for inguinal, Mayo for umbilical, and Moschcowitz for femoral, are to be preferred.

The accidents subsequent to, and after-consequences following colectomy, may be classified as those due to:

1. Failure of the suture. This is most likely to occur in the presence of peritoneal infection. In this relation, Chlumsky's observations are of much interest. He has shown that the union of intestinal wounds is firmer upon the first than upon the three following days; that from the fifth onward the strength steadily increases, while at the seventh it should be thoroughly secure.[1]

Local stitch abscesses are not likely to occur if the method of von Eiselberg is used, the technique is perfect, and the vascular supply is not greatly interfered with. This complication may occur with colectomy and the eighth or ninth day is that on which failure is prone to occur and therefore care should be exercised at this time, in the use of enemata and purgatives.

2. Formation of adhesions is most frequent in the presence of infection and one must remember that there is a considerable denuded area, with serum exudation, and a fruitful soil for spreading infection and forming adhesions, especially when there is a slow leak from the line of suture.

3. Shock, due to loss of blood, anæsthetic, exposure of abdomen and handling of its contents, has not been troublesome in any case and will be avoided by careful technique.

### CASE REPORTS

CASE 1. No. 18634. City. Inf. At. G. H. Operation by Dr. Willard Bartlett at which I assisted and through whose courtesy I include the case. Patient, age 72, white, male, laborer, admitted to City Hospital, October 17, 1910, with enormous bilateral inguinal hernia, reaching on left side to about 1 inch above knee and the tip consisting of a hydrocele. On the right side the contents extended downward about 5 inches and were partially reducible.

A hernia had been present on the right side for the past 30 years and on left side for about 20 years. No history of trauma. Height 5 feet, 6 inches. Weight 150 pounds. Gonorrhœa at 44 years. Arteries, sclerotic. Smokes, chews, and drinks in moderation. Small amount of albumin in urine.

*Operation* November 29, 1910, under ether anæsthesia. Right hernia incision 4½ inches long; small intestine found in sac, and returned to abdomen and

[1] Kocher. Chir. Oper., p. 937.

radical herniotomy with mattress iodized silkworm-gut sutures, performed. Left sac contained almost all of the large bowel extending from just above the sigmoid and including the cæcum and about 3 inches of the ileum, and reduction was impossible. Operation, lower 3 to 4 inches ileum and ascending, transverse, and descending colon were removed and the ends were whipped over after Murphy button was inserted. Lateral anastomosis by Murphy button, mesenteric vessels ligated and hernia repaired in usual way. Incision over scrotum, hydrocele sac exposed, incised, and everted, and the excess removed — several sutures at neck. Closure of scrotal skin by interrupted silkworm-gut sutures.

Cæcum was very hard and appendix was bound down in adhesions (chronic appendix).

*Postoperative course.* December 6, 1910. Wounds healed and patient convalescing. December 14, 1910. Patient doing nicely and allowed to get up (16 days after operation).

*Note.* X-ray failed to show Murphy button, yet patient did not know he passed it. December 17, 1910. Stool normal, 3 per day, and feels well. Some induration about wound. February 23, 1911. Sent to City Infirmary. Patient died November 30, 1911, one year after operation, of myocarditis and was turned over to Anatomical Board, on December 1, 1911.

The following case is interesting and gives a good idea of some of the difficulties encountered.

CASE 2. Patient, white, female, 51 years of age, mother of eight children, was seen by me, April 19, 1915, at her home in bed, and she gave the following history: About 22 years ago, and after she had had four children, she developed a mass in the left groin about the size of a pigeon's egg; this mass gradually grew larger and though formerly reducible had become irreducible. It had increased enormously in the past two years and she had gained considerable in weight; now very obese. She blames the rupture on childbirth, and claims that it became larger after each pregnancy.

Her mother suffered from a double hernia and a brother has a hernia.

She had suffered much pain, frequent incarceration and lately had very numerous attacks of "gastritis," relieved usually by morphine and bed rest. For some time she has been greatly incapacitated and spends much time in bed for relief of her symptoms, and to avoid a dragging sensation. No bladder or rectal symptoms other than patient arising two or three times a night to void her urine. On the inner aspect of the mass, there is quite an area of tenderness.

*Examination* reveals an enormous mass, nearly as large as her thigh, reaching nearly to knees, tympanitic on percussion, giving an impulse on coughing and over which an occasional gurgling sound could be heard, and which was found to emerge from

Fig. 2, Case 2.

beneath the left Poupart ligament. The left labia majora was stretched so as to partly form the inner wall. Urethral catheterization was impossible and specimen of urine not obtainable. The patient was rather stout and the fat hung in a broad fold about the lower abdomen (see Fig. 2). Her skin showed the characteristic evidences of intestinal stasis and toxæmia, though the patient denied constipation. The heart and lungs were apparently normal.

*Operation* April 26, 1916. After preliminary of morphine and atropine, a 4-inch incision parallel to left Poupart's ligament was made and then lengthened as it curved downward over the center of mass, and the sac exposed.

On opening the neck of the sac, I found a large pouch of peritoneum above Poupart's ligament and when traced downward it communicated with the enormous sac of the femoral hernia through a fist-sized opening over which Poupart's ligament could be felt above, symphysis and Gimbernat's ligaments internally, and bone and muscle behind.

I then opened the sac below Poupart's ligament, near its center, and found it to contain the entire colon — (cæcum, ascending, transverse, and descending colon), all of the ileum and part of the jejunum, as well as the entire omentum more or less cystic, and a small part of the stomach.

About one quart of serohæmorrhagic fluid escaped on opening the sac; the small bowel was distinctly cyanotic and had distinct plaques of fibrin over isolated areas; the mesentery of the small bowel showed similar patches of fibrin and many

petechial hæmorrhages; this process was not so well marked on the colon and I called attention to the fact that the fat was so thick between the layers of the mesentery as to resemble lipomata though uniform in its distribution and rendering it very difficult, and at times even impossible, to distinguish between what was gut and what was fat. On passing the hand into the abdomen it was found to be practically full of fat and no abnormalities could be felt in the pelvis.

It was then evident that torsion of the mesentery had taken place at various times and was becoming more frequent as the intestines slid down into the sac, made necessary by the increase in intra-abdominal fat, large hernial opening, and the consequent expulsion from their normal habitat. There were no evident bands of scar tissue in the mesentery and the attacks of so-called "gastritis" were probably due to dragging on the mesentery and to a chronic partial occlusion due to an incomplete mesenteric twisting. Peristaltic waves were not visible and there seemed to be a loss of tone to the intestinal musculature, as observed by Barker, following obstructions. It was therefore evident that the contents of the sac could not be reduced partly or *en masse*, and as evidences of torsion of the mesentery were plain, I chose colectomy as a desperate effort to save the patient.

I began the resection in the ileum, about two feet from the cæcum, then mobilized the cæcum, and continued the resection to include the ascending, transverse, and decending colon. The mesentery contained so much fat that only a very small part could be included in the clamps and as the fat fused with the intestine one had to be very guarded and careful to avoid opening the bowel. The mesentery was ligated in clamp sections.

I then closed over the stumps of both ends of the intestine after the method of von Eiselberg (Thrice); and then performed ileosigmoidostomy by the lateral method.

Still the mass was far too large to permit of anything like reduction so I removed practically all of the great omentum. Even after doing this, reduction could not be affected.

I then had the patient put in extreme Trendelenburg position, and under deep ether narcosis succeeded in effecting a reduction. Having observed considerable blood and serum in an abdomen following such extensive operations, I established dependent drainage through the left loin with a rubber tube.

Careful examination after reduction revealed an opening in Poupart's ligament the size of the fist, with femoral vein to the outside, Gimbernat's and Cooper's ligament internally, the pectineus and bone posteriorly.

The sac was then found to be about the size of a two-gallon pail and Poupart's ligament presented a vertical serrated tear, which probably increased with each successive labor due to an increase in the cubic contents of the hernia. I ligated the sac beneath Poupart's ligament with an internal purse-string suture, and removed the redundant sac and skin, at the same time fashioning out skin flaps to cover the inner aspect of the groin and preserve a sort of labia.

Closure of the opening in Poupart's ligament was effected by suturing the ligament to the underlying muscle by interrupted mattress sutures of No. 2, 20 day chromic catgut. Skin was closed with interrupted silkworm-gut sutures and Michel clips. One rubber and one cigarette drain was inserted through a dependent stab wound near the left thigh.

The patient was then gradually returned to the horizontal position. I then hastily performed a Ferguson operation to cover the defect above Poupart's ligament and the skin was closed with interrupted silk worm-gut sutures and clips.

The patient's stomach was washed while she was on the table and the dressing being applied. She was returned to bed with a pulse of 104, placed in moderate Fowler position and continuous proctoclysis started.

*Postoperative course.* The next day April 27, she complained of headache, became delirious, breath urinous, and there was a twenty-four-hour output of less than 4 ounces of urine, brownish in color, loaded with albumin and containing many finely and coarsely granular casts. Her pulse became irregular in volume and rhythm and her blood-pressure, which prior to the operation was 90 millimeters of mercury, rose to 130 millimeters.

The tongue was dry and coated and at 5:00 p.m. on April 27, 30 hours after operation, she was suffering from an alarming anuria due to uræmia. I then forced her to take by mouth, water in moderation, lemonade (without sugar), potassium acetate lemonade, 5 grains to each glass of water, taken in 1-ounce drinks, and digitalin 1/50 grain at 2-hour intervals. In addition she received 650 cubic centimeters saline by hypodermoclysis within 12 hours and absorbed it well. At about this time she began to retain, for the first time, the proctoclysis at 20 drops per minute and during the second night took a pint and a half. Her urinary output arose and showed 11 ounces in 12 hours, pulse improved and she stood thus. Pulse 130, respiration 26, temperature 99.6° in axilla, blood pressure 124 millimeters tongue moist and urinous breath had disappeard. Mentality clear to begin her second postoperative day.

*Second postoperative day.* Urine clearing up. Wound dressed and left flank drain removed. The groin dressing was saturated with serohæmorrhagic discharge, drains shortened, wound margins rather dusky colored and there was moderate swelling, abdomen not distended. Salt solution enema yielded few particles of fæcal matter and much flatus and thereafter patient became comfortable and she perspired freely.

*Fourth postoperative day.* Pulse 96, respiration 26, temperature 98.4°, considerable sero-hæmorrhagic discharge with urinary output now about 60

ounces in 24 hours. Patient saturated dressing with urine and fæces several times necessitating change of dressings. Bowels moved well of own accord.

*Sixth postoperative day.* Pulse, respiration and temperature now normal. Clips and stitches all removed. Some sloughing about stab groin drainage wound and in groin, opened and packed open with gauze. Patient put on broths, peptonized milk and custard, etc. Bowels move every day and are under patient's control now.

*Eighth postoperative day.* Infection of groin clearing up and evidently bacilli coli infection from involuntary control of excretions.

*May 10, 1915, thirteenth postoperative day.* Urinary output has fallen to 15 ounces, in 24 hours. Tongue coated and pulse has risen to 132, respiration 28, temperature 100.4°. Bowels move 2 or 3 times per day now and patient has returned to involuntary action of bowels and urine. Some dyspnœa, wounds doing well. Patient was formerly taking diuretin, 10 grains four times per day and water abundantly and so I returned to the same treatment, adding digitalis. Patient insistent about getting up in chair.

*Fifteenth postoperative day.* Pulse continues rapid along with threatened suppression of urine and hæmaturia — output now about 15 ounces and containing large amount of albumin, many hyaline and finely granular casts, many red cells and few leucocytes — patient irritable and restless and involuntary passage of fæces and urine continuing — pulse at times weak and thready.

Wounds clearing up nicely. Patient put up in chair for 20 minutes, after which she returned to bed and slept well. Sweats produced twice daily.

*Seventeenth postoperative day.* Pulse 124, respiration 30, temperature 99.8°, tongue dry and coated. Blood-pressure has risen to 144 millimeters. Patient stuporous. Has voided only 2 ounces of urine in last 7 hours even with a pint and a half of saline per rectum. Hypodermoclysis 375 cubic centimeters; sweats; diuretin, calomel, digitalin and potassium acetate continued.

*Eighteenth postoperative day.* Pulse rose to 160. One-eighth grain pilocarpine (hypo) brought about free perspiration and bowels moved well with two drams Rochelle's salts. Wounds healing nicely in spite of frequent saturation with urine and fæces. Epson's salts, 20 cubic centimeters and strychnia 1/30 grain three times during the day. Liquids and water abundantly by mouth.

*Twenty-first postoperative day.* Patient up for three hours on porch in chair. Pulse 112, respiration 24, temperature 97.8°, bowels moving 3 to 4 times a day. Urinary output increasing in spite of *very cool weather.*

*Twenty-fourth postoperative day.* Patient all smiles; urination and defæcation voluntary.

*Twenty-sixth postoperative day.* Urine shows trace of albumin, occasional cast, and a good many leucocytes and some epithelium and is again clear and of normal color. Patient walked for first time and went home in auto this evening. Wounds practically well. Returning home, she continued nervous and had 3 to 4 bowel movements a day.

*Thirty-sixth postoperative day.* Patient was found in room of saturated urinous atmosphere in uræmia, from which she died in a few minutes.

Her wounds had almost healed and I regret that I was unable to obtain a photograph as I had hoped to show the result when they were healed.

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# EXOSTOSES OF THE ORBIT

## With Case Report[1]

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Surgeon to the Ohio Valley General Hospital

THE theme of orbital exostoses has received very little attention in either surgical or ophthalmological writings in recent years.

Some valuable contributions may be found, however, in the older literature, in any of the great systems of the eye; for instance, one edited by Norris and Oliver, Bull's article, the *Graefe-Saemische Handbuch der Gesamtem Augenheilkunde;* and the second volume of the *Traite des tumeurs de l'oeilde obrite et des annexes*, by Lagrange. A valuable paper may be found, by J. A. Andrews, on "Osteomata of Orbit" in the *Medical Record* of September 3, 1887.

The history of a case of unusual interest follows:

Male, age 26, farmer, referred by Doctor Rusk, of Cadiz, Ohio. Family history negative, no previous morbid personal history.

Fifteen years ago, without apparent cause, there was noticed a small, hard lump within the right orbit, on the nasal side. The hard, bony mass,

[1] Read before the West Virginia State Medical Association, Wheeling, May, 1916.

Fig. 1. Exostosis of the orbit.

developing in the direction of least resistance, soon encroached upon the orbit; but many years passed before it became either unsightly or dangerous. It was only a few months before admission that its pressure seemed to impair the integrity of the eye with a blurring vision, mild diplopia and pain.

The patient entered the Ohio Valley General Hospital, an athletic young man, normal in every particular, except the right orbital tumor for which he came for treatment.

A hard, rounded, bony tumor, about the size of an English walnut, protruded from the nasal side of the right orbit. The surface or outer crust of the mass presented several rounded openings, the size of the head of a pin, leading to the interior of a less resisting material. The mass had by years of pressure and erosion pushed its way through and beyond the upper lid, and had crowded the eye with unyielding force to the outer orbital wall, and protruded well beyond the orbital margin.

*Operation*, January 6, 1916; ether narcosis.

In attempting to remove the exostosis some difficulty was experienced in locating the point of origin or base of the mass, but after dissecting loose the encapsulating periosteal sheath which surrounded the proximal two-thirds of the growth, its origin could be traced in the direction of the ethmoid bone.

By a process of prying or leverage, and well directed to-and-fro force, with the aid of a strong volsel-

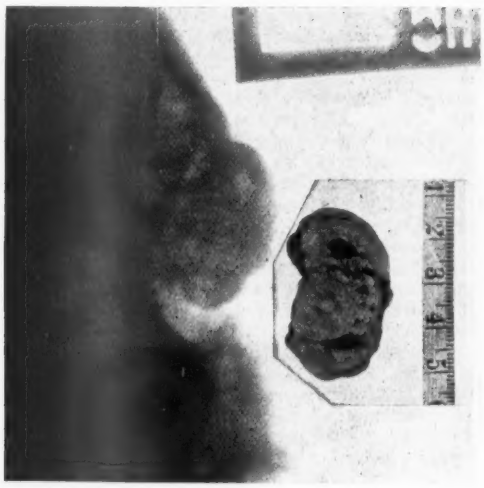

Fig. 2. X-ray plate before operation.

Fig. 3. Exostosis removed from patient. Note the eburnated exterior and rounded openings leading to less resisting spongy bone beneath.

lum forceps, the pedicle was broken through at its point of attachment and the tumor removed.

It has been suggested that in the sessile growths, of ivory-like hardness, holes may be drilled by means of a dental engine, and the operation subsequently completed by means of the chisel and mallet; but this procedure was not necessary as the pedicle of the tumor was composed of a much less dense bone than the ebonated exterior portion.

The bleeding at first was profuse, filling the nose, pharynx, and mouth, probably due to the rupture of the engorged veins in the submucous and periosteal structures; this was soon arrested by a tamponade.

The unguinal phalanx of the index finger could be easily carried into the space corresponding to the orbital plate of the ethmoid, and within this large cavity the broad, rough base could be appreciated from which the pedicle had been forced.

### CLASSIFICATION AND ORIGIN

While orbital osteophytes, periostoses, hyperostoses, or exostoses have all been (1) classified together for the sake of convenience, what are commonly known as exostoses are very hard tumors, having an ivory-like shell; so hard are they, at times, that the usual bone cutting instrumentation makes but little impression upon them (exostosis eburnea). De Schweinitz (2) has described the condition beneath this hard exterior, in some of them, as made up of a spongy bone;

or the tumor may be of a cartilaginous consistency. The non-malignant orbital exostoses, like a sarcoma, may originate from inflammatory exudates from the periosteum, but, unlike the malignant growth, their development is very slow; or they may grow immediately from the diploe of the bone. In the latter case they are likely to extend at the same time into the orbit and into one of the neighboring cavities (3). In the case here reported the tumor was fifteen years attaining the size of an English walnut.

In those cases in which an orbital exostosis pushes its way beneath the lid, one can well understand that its removal becomes a much more difficult procedure than the variety here described, where, through pressure necrosis, the tumor has become extrapalpebral.

### ETIOLOGY

It has been suggested that we may look for the cause in an abnormal embryonic condition of the bone-cells. They may be congenital or develop as a result of trauma. Syphilis, which might be thought a frequent cause, is a rare or even doubtful factor.

### SYMPTOMS

Exostoses give no pain on manipulation; when percussed with a metal instrument they yield a note similar to striking bone or stone.

Any symptoms referable to the eye, such as visual disturbances, optic nerve changes, hyperæmia, or papillitis, would naturally arise from degrees of pressure; and as Bull has pointed out, encroachment upon the cavity of the skull and its contents may result in gradually increasing cerebral symptoms.

### OPERATIVE COMMENT

The hemispheroidal shape and sessile attachment usually observed in these tumors often make their removal most difficult. It may be imperatively necessary early in the operation to determine the point of attachment of the tumor, for to ruthlessly chisel or drill through the densely resisting pedicle, with the brain in dangerous proximity, surrounded as it is with infective material, would make the operation an extra hazardous performance.

Berlin (4) has collected thirty-two cases in which extirpation of orbital osteomata

Fig. 4. Patient ten days after removal of exostosis.

has been performed. Of this number eight died, 25 per cent. In the sixteen cases of this series in which the growth was situated in the roof of the orbit, six died, thus giving a mortality of 38 per cent. The cause of death in these cases was a meningitis, encephalitis, and abscess. This writer advises the greatest conservatism when the growth occupies the orbital plate of the frontal bone.

Fuchs (5), of Vienna, has suggested, when the eye has been pushed out of the orbit by a large osteoma and has already caused blindness, it is sometimes better to relieve the patient of his troubles by enucleating the eye, rather than to expose him to the dangers of an extirpation of the growth.

The eyeball must be carefully guarded when leverage is attempted in the extirpation, and precautions must also be directed toward preserving the pulley of the superior oblique, the tendon of the obicularis and levator palpebræ muscles. Again, the integrity of the infra-orbital nerves and the lachrymal gland must not be compromised.

A few cases of exostoses have been reported (6) in which a cure resulted from necrosis and spontaneous separation.

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# ECTOPIC PREGNANCY

## A Report of 106 Cases

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IT is the purpose of the writer to present for review the results obtained from observation of 106 cases of ectopic gestation. The reasons for this paper are threefold: (1) to see whether or not among these cases some new facts of interest may be discovered; (2) to find out how near the clinical picture of these cases accords with the findings of others; (3) to emphasize certain features of the disease which seem to the writer particularly important in the light of our present knowledge of ectopic gestation.

The cases extend over a period of years and all have been under my personal observation in private practice and while on service at the Lincoln, German, and Sloane Hospitals. Many of the conclusions, as will be seen, are not based on all of the 106 cases, for unfortunately some of the histories are incomplete or the necessary data could not be obtained. When such is the case, a statement to that effect will be made.

### ETIOLOGY

The causes of ectopic gestation, both actual and theoretical, as obtained from a review of the literature may be arranged in the following manner:

Diseases (a) of the tube proper causing loss of cilia, loss of peristalsis, and cicatricial contraction of the tube:
1. Salpingitis—simple, purulent, and tubercular.
2. Torsion of the tube wall.
3. Cervico-abdominal fistulæ after hysterectomy (Koeberlé).

Diseases (b) outside of the tube causing pressure on tube:
1. Fibroids.
2. Cysts.
3. Peritoneal bands and adhesions.

Tumors—polypi in the tube.

Congenital defects:
1. Maldevelopment.
2. Decidual reaction of uterine tube (Webster).
3. Diverticulum.

I. In this series of cases the following conditions bearing on the etiology were found:

| | |
|---|---|
| Previous simple or suppurative condition of the uterus, ovaries, and tubes | 20 |
| History of Bartholinian abscess | 2 |
| Previous ectopic gestation | 5 |
| Fibroid tumors of the uterus | 2 |
| Ovarian cyst | 3 |
| Appendicitis | 2 |
| Operation for prolapse and ventral hernia | 1 |
| Total | 38 |

Of the other 72 cases no cause could be obtained. There were no congenital defects reported from the laboratory. The macroscopical appearance of the tube on the other side was normal.

II. *Age.* The age of these patients ranged from 19 to 43 years. The average age was 29½ years. The disease in 50 cases occurred before 30 years of age, 28 cases before 25 years, 22 cases above 35 years.

III. *Time of occurrence* of the disease from the *date of marriage*, in 72 cases. The earliest was 1½ months with no history of infection and the latest 18 years without history of previous infection. Sixteen cases occurred about five years from marriage, 18 about 8 years, 12 about 15 years, and 26 within the first two years of married life. No reports were obtainable in 34 cases.

IV. *Time of occurrence* of the disease from the *last pregnancy.*

| | |
|---|---|
| Within eight months of previous pregnancy | 7 |
| Within two years or less of previous pregnancy | 43 |
| About 5 years from previous pregnancy | 10 |
| Total | 60 |

Forty-five cases out of 85 followed labor at term, 40 followed miscarriages. Nine patients had not been pregnant before, the ectopic pregnancy occurring at intervals of 6 weeks to 10 years: (1) 4 cases between 5 and 11 years; (2) 3 cases between 1 and 2 years; (3) 2 cases between 6 weeks and 3 months.

V. *Menstrual history* in 96 cases.

| | |
|---|---|
| Normal (28 days, 3 to 4 days' duration) | 51 |
| Profuse | 30 |
| Scant | 6 |
| Irregular (delayed in 5, short in 3) | 9 |
| Total | 96 |

A history of dysmenorrhœa was obtained in 47 cases.

VI. *Recurrence of ectopic pregnancy* occurred in five patients.

*Conclusions.* On the basis for the supposed causes of tubal pregnancy, a cause for the abnormality was present in about one-third of the cases. Of the other two-thirds no cause was ascertainable. The age, the marriage period, the relation in point of time to previous normal pregnancy or miscarriage, and previous sterility appeared to have no particular bearing on the etiology. One case occurred while the mother was nursing her child and had not menstruated from the time of her delivery. The recurrence of ectopic pregnancy might possibly have some bearing on Webster's hypothesis, especially as one of these cases occurred in the stump of the tube that had been the seat of previous ectopic pregnancy.

PATHOLOGY

| | |
|---|---|
| 1. Site of the disease in 100 cases: | |
| Right | 54 |
| Left | 46 |
| Double | 2 |
| 2. Site in the tube in 106 cases: | |
| Inner half | 38 |
| Outer half | 32 |
| Interstitial | 2 |
| Ovarian | 2 |
| Not obtainable | 32 |
| 3. Termination of pregnancy: | |
| Tubal abortion | 55 |
| Unruptured (living) | 6 |
| Tubal mole | 5 |
| Erosion of tube | 21 |
| Rupture of tube | 4 |
| Abscess with fœtus | 1 |
| Condition not determined | 14 |
| 4. Occurrence: | |
| Single in | 103 |
| Double in | 2 |
| Associated with normal pregnancy | 1 |

In one case the ectopic occurred twice on the same side—in the stump of the former tube.

| | |
|---|---|
| 5. Duration of pregnancy: | |
| Youngest | about 3 weeks |
| Oldest | about 5 months |
| Average | about 6 weeks |

*Conclusions.* The pathological conditions found lead to the following conclusions:

1. That ectopic pregnancy occurs about as often on one side as the other. If previous inflammatory condition of the tubes were the sole cause, we would expect the condition to be more prevalent on the left side.

2. That the pregnancy is located about as frequently in the inner half of the tube as the outer, that interstitial and ovarian pregnancies are of rare occurrence.

3. That tubal abortion is the variety of rupture most commonly found, whereas of the other varieties erosion of the tube is very much more common than rupture from overdistention. Severe hæmorrhage may occur from tubal abortion and erosion of the tube. It is uncommon for the ovarian artery to be eroded. Rupture into the broad ligament is conspicuous by its absence.

4. That double ectopic pregnancy is very uncommon; that ectopic may be associated with normal pregnancy; that interstitial ectopic may push its way into the uterus and continue to grow; that it is possible for ectopic pregnancy to occur twice on the same side.

5. That the termination of ectopic pregnancy usually occurs in about six weeks, pregnancies later than three months being uncommon.

6. That most ectopic pregnancies die (a) and are discharged into the abdominal cavity and absorbed; (b) they become a tubal mole and are absorbed; (c) the fœtus disintegrates and forms an abscess in the abdominal cavity.

SYMPTOMATOLOGY

A. *Pain.* Two general varieties of ectopic gestation are recognized clinically: (1) The acute violent form with excessive hæmorrhage and shock. (2) The subacute form with one or more minor attacks of acute pain lasting over a considerable period, in the intervals between which the patient may feel fairly well or be disturbed by dull pain or abdominal tenderness. Hæmorrhage from the uterus may be continuous or intermittent. In this series of 106 cases 15 were of the first type and 91 of the latter.

The character of the pain in 88 cases was intermittent and cramp-like in 62, dull continuous in 15, sharp continuous in 8, and pain was slight in 3 cases. History of sudden collapse, falling to the floor, or being carried to the bed occurred in 26 cases. Out of 106 cases, there were single attacks of pain in 26 cases, two attacks in 16 cases, and several attacks in 64 cases. Uterine bleeding was closely associated with all attacks of pain in all cases but 11. In these the flow began some considerable time after the pain. Pain came first in 13 cases, bleeding first in 19, and both together in 23 cases, out of a total of 55 cases. Pain was referred generally to one or the other side of the abdomen, depending upon the site of the lesion. In 3 cases, however, both sides were equally painful, and in two the pain was referred distinctly to the healthy side.

B. *Menstrual history* in 95 cases.

| | |
|---|---|
| No interruption of the normal menstrual period in | 50 cases |
| One period skipped in | 41 cases |
| Two periods skipped in | 2 cases |
| Five periods skipped in | 2 cases |

Uterine hæmorrhage was absent in two patients and bleeding continued intermittently for five months in two patients. The average duration of bleeding was about 18 days, was intermittent in a majority of the patients, but continuous in a great many.

C. *Temperature* in 106 cases. Lowest 97° F., highest 103° F. The average morning temperature was 98.8° F., the average evening temperature was 100.1° F. (mouth). Few cases ran a normal temperature throughout the 24 hours.

D. *Pulse* in 106 cases: The range was from 62 to imperceptible; the average morning pulse being 78, evening 104.

E. *Blood count.* The examination of the blood taken as a whole was not satisfactory as an aid to diagnosis. A chart of 27 cases selected at random will show how difficult it is to draw any conclusions of value.

Eighty-two per cent of the cases showed some diminution in the number of red cells; 70 per cent showed increased leucocytosis, with corresponding increase in the polymorphonuclear cells. It seemed possible to gather from observation of these blood

BLOOD-COUNT CHART

| Red cells | Hæmaglobin | White cells | Polymorphonuclear cells, per cent | Pulse | Temperature, F. |
|---|---|---|---|---|---|
| 3,800,000 | 62 | 21,600 | 87 | 120 | 103° |
| 2,700,000 | 60 | 21,000 | 88 | 100 | 97.6° |
| 3,000,000 | 32 | 13,000 | 93 | 132 | 101° |
| 2,100,000 | 30 | 28,000 | 84 | Imperceptible | 99.6° |
| 4,400,000 | 82 | 15,000 | 80 | 98 | 98.4° |
| 4,200,000 | 78 | 8,000 | 65 | 120 | 100° |
| 4,300,000 | 80 | 11,000 | 74 | 80 | 99.6° |
| 4,000,000 | 80 | 10,000 | 84 | 112 | 102° |
| 3,500,000 | 72 | 17,000 | 80 | 76 | 99.2° |
| 4,500,000 | 85 | 8,000 | 76 | 88 | 99° |
| 2,700,000 | 38 | 9,200 | 77 | 104 | 102° |
| 3,500,000 | .. | 12,000 | 76 | 92 | 98° |
| 4,800,000 | 85 | 8,000 | 76 | 98 | 100° |
| 3,500,000 | 72 | 17,000 | 80 | 100 | 100° |
| 4,200,000 | 80 | 10,000 | 76 | 72 | 99.4° |
| 4,500,000 | 82 | 11,000 | 80 | 118 | 101° |
| 3,700,000 | 78 | 26,000 | 85 | 120 | 102° |
| 3,400,000 | 60 | 36,000 | 88 | 138 | 101.5° |
| 2,800,000 | 60 | 14,500 | 79 | 110 | 99° |
| 4,000,000 | 60 | 10,000 | 80 | 98 | 99.6° |
| 3,200,000 | 58 | 22,000 | 94 | 138 | 103° |
| 4,000,000 | 65 | 16,000 | 87 | 100 | 100.6° |
| 4,700,000 | 82 | 12,000 | 80 | 112 | 101° |
| 2,700,000 | 38 | 21,000 | 85 | 74 | 101° |
| 4,500,000 | 85 | 6,600 | 76 | 80 | 99.6° |
| 4,200,000 | 82 | 10,200 | 80 | 104 | 99.6° |
| 2,600,000 | 30 | 22,000 | 92 | 150 | 98.6° |

counts one particular fact: that as the number of red cells decreased the white cells showed a corresponding increase both in number and polymorphonuclear cells. Where there was an associated rise of temperature of any moment, the leucocytosis and polymorphonuclear cells appeared to increase in greater proportion. In many severe cases the noticeable symptoms noted were a considerable rise in temperature, rapid pulse, low red cell count, high white cell, and polymorphonuclear increase. This sequence, unfortunately, did not always follow and, as has been mentioned, the blood picture in many cases was disappointing and confusing.

F. *Urine.* The examination of the urine of 106 cases revealed a fact of some considerable interest, possibly of some importance. Thirty-eight cases showed anywhere from a trace to a small percentage of albumin and associated with this hyaline and granular casts. This evidence of possible degenerative change in the kidney must point to the excretion of some deleterious material, for it occurred too often to be merely a coincidence.

Symptoms such as morning nausea, increased size of breasts with tenderness, could

not be obtained with any degree of satisfaction. Irritability of the bladder occurred in 40 cases; of the rectum in 22 cases out of 106.

In 86 cases rigidity of the abdomen occurred 51 times. Distention was present in 66 cases out of 106. Tenderness over the site of the disease was present in all cases. This tenderness was exquisite and entirely out of proportion to the amount of rigidity and distention of the abdomen. This was particularly noticeable on bimanual examination and again where traction was made on the cervix. Out of 106 cases examined, a mass was felt in 85 cases, bimanually. Some enlargement of the uterus could be determined in about half the cases and the cervix was reported softened in 78 cases out of 106. One feature of diagnostic interest was the position of the uterus. Out of 106 cases examined the uterus was forward in 87 cases and retroverted or flexed in 19.

*Conclusions from physical examination.* In the differential diagnosis between ectopic pregnancy and inflammatory conditions of the tube or appendix, the symptoms of rigidity and distention are of no particular value. Two features, however, seem to be of some value: (1) The peculiar exquisite tenderness of one or the other side of the pelvis determined by bimanual examination out of all proportion to the rigidity and distention of the abdomen. (2) The forward position of the uterus. In inflammatory conditions adhesions formed tend to pull back the uterus in retroposition, whereas in ectopic the pathological condition does not exist long enough to cause this condition. Where there has been a previous inflammatory condition, the position of the uterus is of course of no assistance. The peculiar doughy feeling of the pelvic mass is valuable as a diagnostic sign, but unfortunately it is not present as often as one would expect and a cæcum or sigmoid distended with soft fæces will often give a similar sensation. A softened cervix simply means congestion, and the enlarged uterus is not easy to determine in early cases.

*Conclusions on symptomatology as a whole.* A review of the facts leads to the following: Ectopic pregnancy is for the most part rather a subacute disease, a disease in which the symptoms continue with one or more exacerbations for one or more weeks, the patient gradually becoming weaker and weaker until relieved by operation or death of the pregnancy. The so-called acute cases, violent cases, are very much in the minority. Therefore, we must think of ectopic pregnancy as a disease comparable to a more or less severe type of salpingitis, many of the symptoms of which it has.

1. The pain of ectopic pregnancy is of importance very much like the cramps of intestinal colic; it is often taken for such. Not all cases have pain of a cramp-like character, however. Very often associated with these cramps is a feeling of faintness, vomiting, chilly sensations, and constipation, misleading the physician in the direction of intestinal disturbance.

2. The classic feature of a skipped period is absent in a majority of cases. This fact is of importance as a warning not to place too much faith in the symptom as a necessary concomitant of the symptom-complex of ectopic pregnancy. One feature of the menstrual epoch is present with considerable regularity—irregular spotting or severe bleeding continuous with menstruation or during the intermenstrual period. The color or the consistence of the blood is of no diagnostic value. Irregular bleeding so often accompanies adnexal inflammation, however, that it is in itself not diagnostic.

3. Ectopic pregnancy is not a disease of normal temperature. Some temperature is present in almost every case, with a range between 99.5° F. and 100.5° F.

4. Pulse rate and blood-pressure are of little diagnostic importance except in those cases where the frequency of the pulse is out of proportion to the temperature.

5. The blood picture is not satisfactory. Leucocytosis is present in a large proportion of the cases, and a low red count is generally accompanied by a high white, but this does not occur regularly and the results are often confused.

6. The presence of albumin and casts in the urine in a large percentage of cases is significant.

7. Irritation of bladder and rectum is much more common than is generally supposed.

8. The physical examination, abdominal and bimanual, reveals the usual signs of peritoneal irritation, tenderness, distention, and rigidity—more or less pronounced; and the bimanual examination often discloses a mass in the pelvis. These symptoms, however, are present in salpingitis. There are certain symptoms, nevertheless, which seem to be of special value: (1) exquisite tenderness out of proportion to other local symptoms; (2) the situation of the uterus in the normal position, movable and not in retroposition fixed; (3) the boggy sensation to the mass in some cases; (4) the enlarged uterus and soft cervix; (5) rarely the blue vagina. In many patients, however, there is nothing but exquisite localized tenderness to guide us in our diagnosis.

### DIAGNOSIS

The analysis of 106 cases of tubal pregnancy leads to the conclusion that there is no one diagnostic symptom peculiar to the condition. The symptom-complex, however, if complete, affords an easy diagnosis. If the patient, who has had previous pelvic trouble and has passed two weeks over her period, is suddenly seized with cramps in the lower abdomen which are localized to one side, if the patient begins to flow, feels weak and vomits, if she has a temperature of about 100° F. with pulse of 120, and she goes to bed and after a few hours is relieved, and in two or three days is able to be up and around only to have the attacks repeated, once or perhaps several times, and if examination reveals a pale woman, with some local distention and rigidity of the abdomen with peculiar exquisite tenderness to one side of the uterus on bimanual examination, the presence of a boggy or elastic mass, the uterus enlarged and in position, the cervix soft, vagina blue, then the diagnosis should be made without any difficulty. Unfortunately, these symptoms are not often assembled in such a satisfactory manner, and the diagnosis is then very difficult. Only too often the uterus is curetted for a supposed abortion or the patient is treated for salpingitis or appendicitis. There should be no difficulty in diagnosing the acute variety of ectopic pregnancy. Out of 106 cases, 6 were diagnosed before rupture, 70 after; in 30 the diagnosis was improperly made.

### PROGNOSIS

Out of 106 cases, 7 died. Five belonged to the acute type, 1 died while being prepared for operation, 2 without operation, 3 following operation, and 1 suddenly thirteen days following operation, in apparently good health, from pulmonary embolism. The mortality is therefore low, and with proper care the patients generally recover.

### TREATMENT

It is not the purpose of the writer to discuss the various methods of treatment of tubal pregnancy. Of this series of cases all with but four exceptions were operated on as soon as the diagnosis was made. Of the 4 cases excepted, 2 were in such acute shock from loss of blood that it was deemed advisable to wait in the hope that the patients might react from the initial shock; the other 2 died before the abdomen was opened.

### CONCLUSIONS

The conclusions reached from observation of these cases would seem to be that all subacute ectopic pregnancies should be operated on at once, removing from the abdomen the tube affected, the fœtus, placenta, membranes. and blood. All acute cases should be operated on at once except cases *in extremis*. In these cases it would seem advisable to wait, watching the patient very carefully. If no improvement occurs in a very short time, operate. Two cases of this series bled to death. The ovarian artery had ruptured in both. One was an interstitial pregnancy. As there is no doubt, therefore, that patients can bleed to death, operation must not be delayed too long in waiting for a reaction in these extreme cases. The abdominal route was chosen in all these cases and it is undoubtedly the only safe procedure to follow. Inasmuch as there were no cases extending to the viability of the child in the series, there will be no discussion of the treatment in this condition.

# DEPARTMENT OF TECHNIQUE

## THE TECHNIQUE OF THYROID OPERATIONS WITH LOCAL ANÆSTHESIA, SCOPOLAMINE AND MORPHIA

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IN the *Boston Medical and Surgical Journal* for October 15, 1914, the writer published his experiences with local anæsthesia in thyroid surgery. Twelve cases were reported, the last three of which had received scopolamine and morphia. At that time he ventured the prophecy that scopolamine and morphia would supply the mental quietude so necessary for the success of local anæsthesia in thyroid surgery.

After a more extensive use of this method, the writer is able to say that the method which he has developed and employed in this series of cases has been everything that he expected of it, except in the instances noted, and has in his hands made thyroid surgery easier, safer, and less worrisome.

The method has now been sufficiently tried out and standardized by the writer to justify him in describing it, and drawing a few not too far-reaching conclusions from his experience with it.

### DESCRIPTION OF METHOD

Two days previous to the day of operation a cathartic is given the patient, none being given the day before operation, in order that the night before operation shall not be disturbed.

On the afternoon before the day of operation the patient is seen and told of the necessity of co-operation on her, or his, part. She is told that apprehension and lack of confidence are two of the most constant causes of the failure of scopolamine and morphia to produce their proper effect. She has impressed upon her the fact that the success of the procedure depends upon what her attitude toward it will be, and is, in fact, almost entirely in her hands. All possible effort is made to win the confidence of the patient in the method. She is assured that if she is hurt or becomes unduly restless she will be given a general anæsthetic. It has also been the writer's custom to ask his goiter patients who have already been operated upon and are still in the hospital, to visit new patients and honestly relate their experiences to them.

With increasing practice in judging these cases, the writer finds himself able in most instances to decide with considerable exactness what the success of the method is going to be with the different individuals.

On the night previous to the operation, ten grains of veronal are administered at eight o'clock.

On the morning of the operation, two hours previous to the hour when it is intended to start the operation, which is at as early an hour as possible, one two-hundredth of a grain of scopolamine with one sixth to one quarter of a grain of morphia, according to the size and age of the patient, are administered hypodermatically.

One hour later, provided the respirations are not stertorous, the pulse irregular, or the patient excitable — conditions which have never appeared in the writer's experience — another two-hundredth of scopolamine and another sixth or fourth of morphia are administered.

After another interval of an hour, at the time set for operation, the patient is visited, and if found sleeping is transferred to the operating room as quietly as possible. If the patient is not sufficiently drowsy, as shown by her remaining awake after being aroused, she is given another dose of one four-hundredth of scopolamine with no morphia.

After the patient has arrived in the operating room, all efforts are directed toward the prevention of noises and jars that would even temporarily awaken her. She is placed on the table so that the neck is on the stretch, and so that no other shifts in position will be necessary.

The neck is lightly washed, wiped over with alcohol, and draped with towels and sheets. Iodine is not used because it obscures the wheals in the skin which show the proper points for the introduction of the local anæsthetic.

An ounce of approximately 2 per cent novo-

Fig. 1. The infiltrated line of incision, and the method of injecting into the skin by holding the skin between the thumb and forefinger.

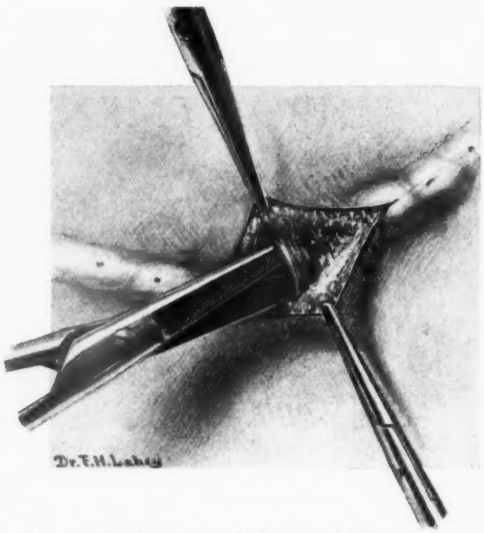


Fig. 2. Showing the method of freeing the platysma, subcutaneous fat and skin from the underlying muscles.

caine solution is now freshly prepared by adding two four-grain novocaine tablets to an ounce of salt solution or sterile water. To this is added fifteen minims of fresh adrenalin solution. The writer fully realizes the strength of this solution, but has had no ill effects from its use, and feels sure that the results with weaker solutions have on the whole been less satisfactory. With this solution it is unnecessary to wait at all before starting the incision. The entire ounce of 2 per cent novocaine solution may be used with safety.

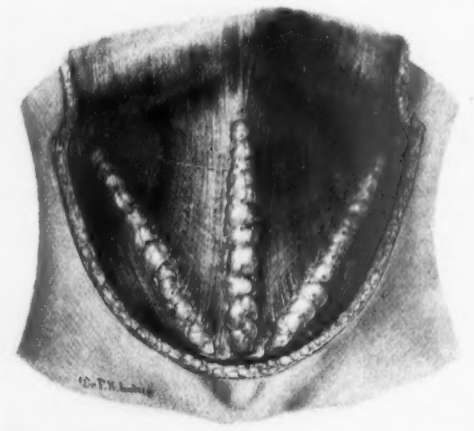
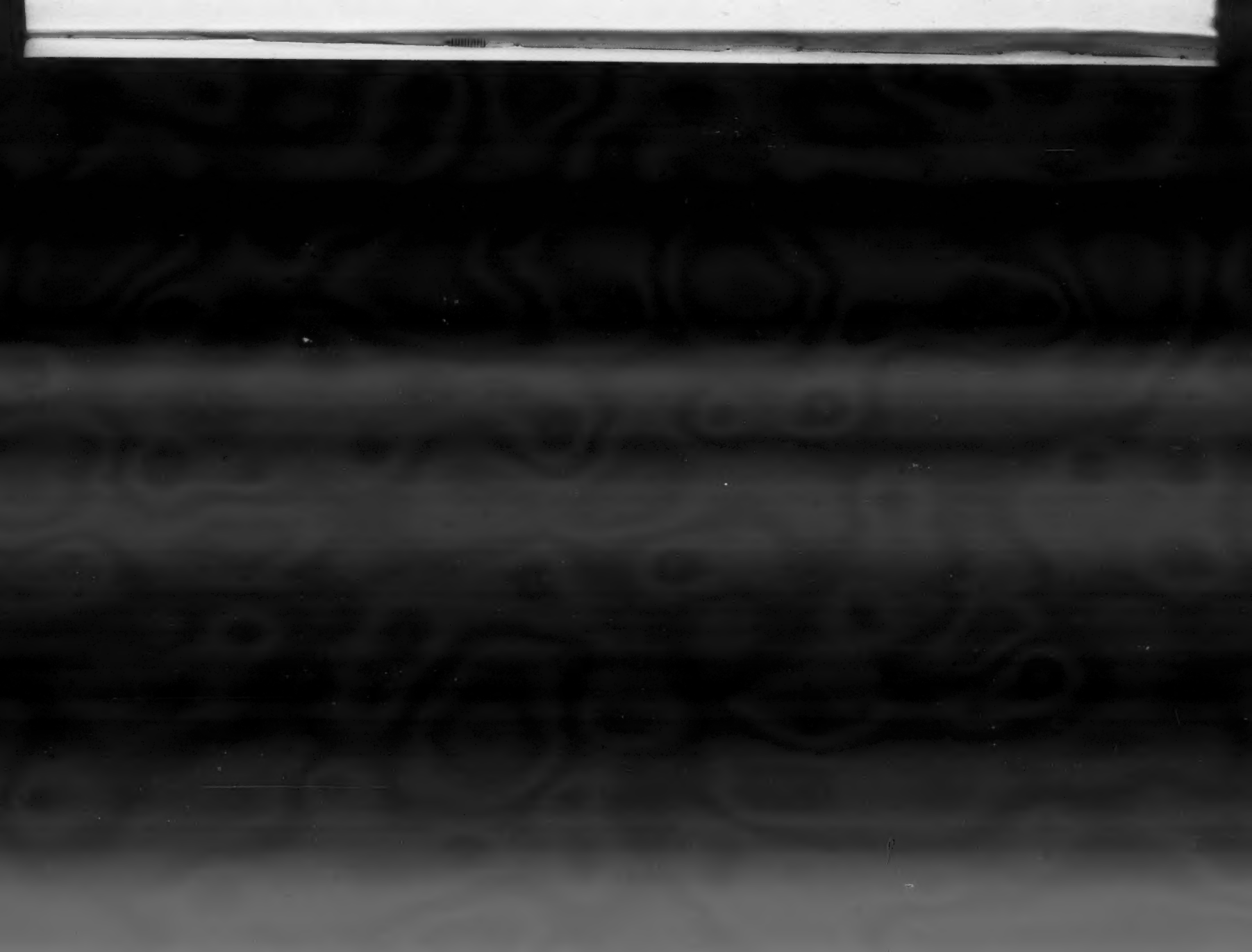


Fig. 3. Showing the flap turned up and the muscles covering the gland exposed, and the infiltrations along the anterior border of the sternomastoid and at the median line. Dotted line shows where clamps are to be applied. At times it will be necessary to inject here.

The first injection is made in the middle of the neck at the point which will correspond to the center of the collar or U-shaped incision. Care is taken to inject the solution into the skin and not into the cellular tissue beneath it. This may be accomplished by picking up the skin of the neck, which is very loose, between the thumb and forefinger, as shown in Fig. 1, so that one is enabled not only to hold the skin fixed, but to feel plainly the tense, hard swelling produced in the skin by the injection, as it bulges the skin out between the fixing and palpating fingers.

It is essential that a fine hypodermic needle be used, as with coarse needles it is almost impossible to make the injection directly into the skin, a large portion of the fluid escaping into the cellular tissue beneath.

The injections are continued from the center outward to one end of the proposed incision, and then starting from the center again, outward to the opposite end, producing the appearance shown in Fig. 1. The ascending limbs of the proposed incision should be injected considerably



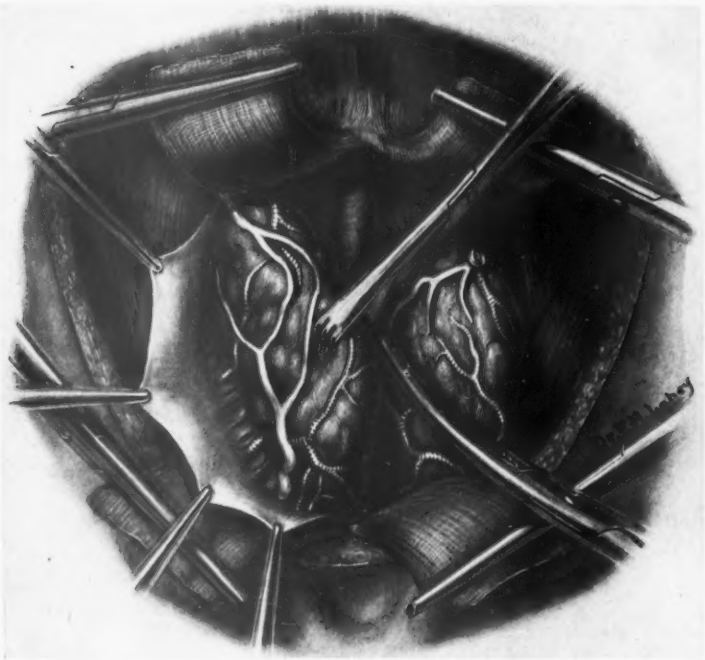


Fig. 4. Showing the gland exposed, the right lobe inverted, and the capsule (exaggerated) put on the stretch. The vessels are shown between the posterior surface of the gland and the capsule. Note that no inferior thyroid trunk appears, only branches of the inferior thyroid vessels being seen. Superior vessels of the left lobe are shown tied, the lobe mobilized and clamped. Isthmus obscured by inverted right lobe.

above the point intended as the upper limit of the incision, for one often finds it necessary to extend the limbs upward in cases with highly located upper poles.

Starting now from one end of the proposed incision, injections of the solution are made along the incision at right angles to the skin, the needle being inserted to a depth of one-half to one inch, according to the amount of subcutaneous fat. From fifteen to twenty minims are injected at a time, at intervals of one and one-half inches. This infiltrates the subcutaneous fat and platysma muscle, both of which contain a few blood-vessels, the cutting of which may at times cause slight pain. When the injection is complete, the appearance will be somewhat similar to Fig. 1. With a sharp knife an incision is now made corresponding to the line of injection, as high as seems necessary on either side. The writer has been pleased with a hollow-ground flexible-bladed knife devised by him and described in SURGERY, GYNECOLOGY AND OBSTETRICS for January, 1912. It is better to make the incision too high than too low, in order not to be handicapped in exposing the upper poles. This incision should extend through the skin down to subcutaneous fat, but not into it. In the illustration (Fig. 2) the incision is shown only at one point.

In the middle of the U-shaped cut, the incision is now deepened with scissors through subcutaneous fat and platysma muscle, so that the blunt pointed scissors may be inserted beneath the muscles by separating the points of the scissors as shown in Fig. 2. The platysma is loosened from its attachment to the underlying structures, sternohyoid, sternothyroid, and sternomastoid. When these structures have been freed for a short distance, by separating the points of the scissors, the platysma and fat are cut with the scissors through the line of the skin incision. More of the muscle is then freed and cut, until the underlying platysma and sub-

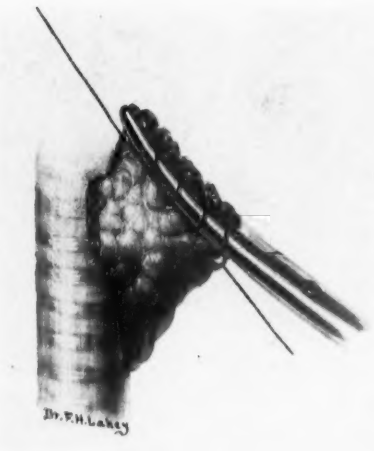


Fig. 5. Showing amount of thyroid tissue left behind, and suture over clamped portion.

cutaneous fat beneath the skin incision have been cut on both sides. The advantage of this method over that of carrying the cut through skin, fat, and platysma with a knife throughout the whole incision, is that the large veins, such as the anterior jugular, running longitudinally on the neck, are not cut across and troublesome hæmorrhage produced. These veins, of which in many cases their are several of the size of a lead pencil and larger, are firmly fixed to the sternohyoid, sternothyroid, and omohyoid muscles. Their attachment to the overlying platysma is but a loose one and permits of very easy separation, as described above. By this method the incision is completed and carried down to the layer of muscles covering the gland, with no bleeding except from those few small vessels which are encountered in the skin and subcutaneous fat.

A double hook is now placed in the center of the incision and the flap which has been marked out by the incision is now turned up, a sharp knife being used for the dissection, and care being taken to avoid as much as possible the large veins spoken of above, which are adherent to the underlying muscles. No injection of novocaine is necessary to carry out this step, as the injection of the ascending limbs of the U-shaped incision has so blocked this area that the dissection is painless.

With the flap turned up and held by an assistant, infiltrations are now made as shown in Fig. 3, along the anterior border of the sternomastoid on each side, and longitudinally in the middle line where the sternohyoids of either side meet. No further injection of novocaine will be necessary except for the purpose of inserting a drain through a stab incision later. The sternomastoids are now freed from the sternothyroids, sternohyoids and omohyoids where they are adherent at their anterior edges, and an incision is made in the median line through the line of infiltration down to the surface of the thyroid gland. The fingers are then swept over the anterior surface of the gland beneath the muscles to free any delicate adhesions between the gland and these muscles. Clamps are placed across the sternohyoid and sternothyroid, and these muscles are cut across and turned up. The operation may then proceed by whatever method of partial thyroidectomy one may favor.

The technique developed and employed by the writer has been as follows: The superior thyroid artery and vein are first ligated between ligatures or clamps. This permits of mobilization of at least the upper half of the gland, and in most cases peeling of that portion from out its capsule on the posterior surface. One may then continue the dissection around the inferior pole with the capsule well demonstrated in the region where it is so important to remain inside that structure. The capsule is cut from the outer edge of the gland, hæmostats are placed on it, and it is put upon the stretch, so that it is always demonstrable. Double hooks are now locked on the external border of the gland and the gland may then be turned bottom side up by dragging the whole gland by its outer border toward the median line. In the illustration (Fig. 4) its upper pole is unligated, so as to show the relation of the gland to the vessels of the upper pole and to those of the lower. The superior vessels of the left side, however, are illustrated as ligated and cut, showing that pole mobilized. The countertraction brought about by pulling the gland to one side and the capsule to the other, puts the branches of the inferior thyroid artery and vein on the stretch, so that they can be clamped close to the posterior surface of the gland, well within the capsule, and away from the region of the recurrent laryngeal nerve. As each set of vessels is snapped and cut, the gland may be carried farther toward the opposite side until its isthmus is completely dissected from the trachea. When this is completed, a clamp is applied to the isthmus at its junction with the left lobe, and the right lobe and isthmus are cut away. The thyroid tissue in the jaws of the clamp is then sewed over and over with plain or iodized catgut, the clamp removed and any additional sutures

Fig. 6. Anatomical dissection of posterior surface of thyroid, showing its relation to nerve, artery, and vein. Note that inferior thyroid artery enters gland at the side and from above, rather than at the bottom from below. Note thyroidea ima artery. Note that gland when in its bed rests on recurrent laryngeal nerve.

necessary to control oozing are inserted. A small sponge is now laid in the cavity from which the right lobe has been peeled, and no attempt made to ligate the vessels already clamped on that side until the remaining portion of the operation on the left lobe has been completed. The left superior thyroid artery and vein are now ligated as on the right, the capsule again demonstrated, the upper portion of the gland mobilized and a clamp applied, as shown in Fig. 4. The point on the gland at which the clamp is placed is to be determined by the amount of thyroid tissue to be left behind. In some cases it will be necessary to apply more than one clamp to completely grasp the whole of a thick gland. The upper portion of the gland is cut away and the clamps sewed over and over with catgut, as at the isthmus (Fig. 5). All vessels are now ligated, clamps removed, and any further oozing controlled by ligature or suture. If the field be completely dry and the capsule of sufficient thickness, its outer borders may be sutured to the stumps of the thyroid, so that the dead spaces made by the removal of the gland are obliterated. If not, a drain is inserted through a stab wound below the line of incision. The neck muscles are then sutured, the skin and platysma restored, and a dressing applied. No further injection of novocaine is necessary in suturing muscles or skin.

In order to demonstrate the anatomy of the posterior surface of the thyroid gland, the writer had made the drawing, Fig. 6, which is a reproduction of an anatomical dissection made under the writer's direction in the anatomical laboratory of Tufts College Medical School. In this illustration the posterior capsule has been removed to show the course of the inferior thyroid artery and the relation of the recurrent laryngeal nerve to that structure, the trachea and the posterior surface of the gland. From this illustration one may see how well the upper portion of the gland may be mobilized after ligation of the superior thyroid artery and vein. By comparing this dissection with Fig. 4, one may see also how traction outward on the capsule tends always to keep the recurrent laryngeal nerve from being pulled from its bed beside the trachea, and how inverting the gland by traction inward allows the vessels to be clamped on the stretch, close to the gland and well away from the region of the nerve.

Fig. 7. Diagrammatic illustration of relation of whole gland to portion remaining after operation.

Attention is called to the thyroidea ima artery appearing in this dissection, and its relation to the gland. It occurs in about 10 per cent of cases.

Figure 7 illustrates the amount of thyroid tissue removed, and its relation to the entire gland — the amount removed being readily increased or decreased by raising or lowering the dotted line indicating the point at which the clamps are applied to the left lobe.

The advantages of this method of operating are that the operation is completed with as little dragging as possible, and that it leaves behind the inferior pole on one side. The writer believes that it is easier and safer to leave behind a portion of the inferior rather than the superior pole for the following reasons: first, since the superior pole peels out of its bed so easily one is surer in that region of wiping off and leaving behind the parathyroid. This is not true of the inferior pole, which is adherent, and where the vessels are multiple and clamped as branches rather than as a trunk. Second, there is less danger to the recurrent laryngeal nerve when the inferior pole does not have to be mobilized. Third, it is easier, since fewer vessels have to be clamped and tied, and less bleeding is encountered.

The writer has records of fifty-seven[1] consecutive thyroid operations in which he has applied this method of anæsthesia. In four the anæsthesia was a complete failure, in that ether had to be given for the whole operation, or should have been given on account of the suffering. Two of these cases received a solution rather than the tablets of scopolamine that were used exclusively before these two cases and have been since; that is, two of the complete failures received a different kind of scopolamine than any of the others in this series. It is said that scopolamine deteriorates in solution. This does not, the writer believes, alter the fact that they were failures, particularly as the two other cases were just as complete failures, although they had received the kind of scopolamine used in all but the two above noted cases.

Three cases were unsatisfactory in that the patients were awake and complaining considerably throughout the operation.

Two cases received a little gas. One was given just enough to get her under while a cyst was dislocated out of the right lobe, a procedure requiring not more than ten seconds. Another acutely toxic case was given not more than a few bagfuls while the right lobe was being dragged upon. In both of these cases the operation was completed painlessly, with no further gas, as soon as the dragging and prying was over. One case received a few whiffs of ether while an intrathoracic adenoma was being extricated with great difficulty from the chest cavity. These three cases the writer believes should be considered failures only to a small degree, since by far the greater part of the operation was completed under the influence of the anæsthesia as administered by the method herein described.

In the remaining cases, response to the scopolamine and morphia varied considerably. Many cases came to the operating room snoring and continued to snore throughout the operation. Some, because of their apprehension, were vainly endeavoring to remain awake until the operation started, but went to sleep and snored as soon as they realized that they were not to be hurt. A few remained half awake but uncomplaining throughout the whole operation. A majority awoke in bed, not realizing that the operation had been done, and having no recollection of it. In the cases requiring ether, relaxation occurred with a much smaller amount of ether than is ordinarily required, and in a very short time.

There were no cases of excitation. The writer wishes to state in this regard that he believes that many patients under the influence of scopolamine and morphia are very easily antag-

[1] This number has now been increased to eighty-three.

onized by commands and harsh remarks, just as are certain individuals while under the influence of alcohol. One of the essential factors, therefore, in this method is that no remarks whatever shall be addressed to the patient. Attempts to reassure her will only serve to awaken her, stir up her apprehension and result often in a failure of the method. If the patient is awakened by strong traction on the gland, by an instrument dropping on her, or by an assistant leaning on her, the operation should be stopped, and perfect quietness maintained. The patient will again sink into a snoring sleep, when the operation may be continued. The writer has repeatedly seen this happen. In the last case cited above, in which a few whiffs of ether had to be administered, he feels that had the patient not been roughly ordered by one of the nurses to put her head down, her resentment thus being aroused, she might have again returned to the snoring state in which she had been until too vigorous prying with the fingers in the chest awakened her, and that the operation might have been completed without the general anæsthetic. This patient had no recollection of the operation.

In discussing the merits of this procedure — local anæsthesia, scopolamine and morphia — it is the writer's aim to present as prominently what he considers its drawbacks as he does its advantages, for he realizes that an individual is prone to become enthusiastic concerning the value of any method that has received so much of his attention as to become almost a hobby.

To the mind of the writer there are certain unavoidable drawbacks to the method, which will prevent its application in all cases.

### DISADVANTAGES

1. Scopolamine and morphia do not act similarly upon all individuals, failing at times to produce a sufficient depth of sleep to make local anæsthesia desirable. It is his feeling that this failure is in part due to the temperament of the patient, and with that a lack of susceptibility to the drug. It is advisable to use the same kind of scopolamine always, and in tablet form.

2. Some surgeons are not themselves of the temperament which permits them to complete such an operation with the deliberateness and gentleness necessary to its success. The writer personally feels that his own temperament is at times somewhat lacking in this respect, and so makes this statement without bias.

3. More time is required for the operation under this form of anæsthesia.

4. Operating room conditions are not always favorable in a large hospital.

5. A higher degree of technical skill is required to perform the operation with local anæsthesia than with general anæsthesia.

6. Objection may be raised by some to the use of scopolamine itself. Since the writer has had no cases where any untoward symptoms either of depression or excitation have occurred, and since he always administers these drugs in fractional doses, he does not see any objection to their use.

### ADVANTAGES

1. It is safer, not only in the cases in which it is a complete success, but even in the cases that are such complete failures as to require ether. There have been no deaths in this series of cases. While it is possible that such a record may be the result of good fortune, the writer is constantly impressed with the fact that the recovery seems to him very much less stormy than in the cases done by him with ether. General statements should bear little weight in such questions as this, but it must be remembered that one's decision as to whether a given case will stand partial thyroidectomy or not, must rest largely upon his general impression of the case. There were several cases in this series which, the writer feels justified in stating, he would not have been inclined to submit to partial thyroidectomy under ether.

2. It is very much easier for the patient. The writer believes this is true because of the fact that the scopolamine and the morphia remove to a large degree the excitement and psychical disturbances which are present when a toxic case enters the operating room in full possession of his or her faculties. The psychical disturbance is almost completely removed in the entirely successful cases: in the partly successful cases it is removed much more than by ether: and in the non-successful cases, those in which ether or gas has to be given, it is at least no worse, for the scopolamine and morphia decidedly diminish the amount of ether or gas necessary in the case.

3. It requires of the same surgeon better technique and greater gentleness than would have to be demonstrated with the patient under ether, and this becomes a further safeguard to the important structures adjacent to the thyroid gland, and to the patient's general condition.

4. It permits of stopping the operation at any time, and the immediate cessation of the further production of shock.

CONCLUSIONS

The writer does not believe that the method will ever become popular in busy clinics or with infrequent operators on the thyroid gland, for self-evident reasons: length of time required for the operation, necessity of personal attention to cases, and increased technical difficulties. But he is inclined to believe that individual surgeons who are interested in thyroid surgery, if they will take time to become familiar with the method, will obtain better results in the long run than with ether or nitrous oxide.

So convinced is he of its value that he would never of choice submit any goiter case to an ether operation without first attempting the operation according to this method.

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# A NEW METHOD OF CONTINUOUS DRAINAGE FOR EMPYEMA[1]

By HERMAN B. PHILIPS, M.D., New York
Ex-House Surgeon, Gouverneur Hospital

IT is a well recognized fact in the medical profession that the treatment of empyema is unsatisfactory. Everyone who has any experience with the condition will agree that present conservative methods of treatment are much behind the times as compared to medical and surgical progress along other lines. A little thought on this question reveals the fact that there are certain surgical and physical principles to be strictly observed before perfection in the treatment can be reached. The present is an era in medicine and surgery where every advantage, every perfection, every detail in thoroughness are combined to improve therapeutic results. No effort, therefore, should be spared to better our almost lamentable results in the treatment of empyema.

The two factors which contribute most to the chronicity of empyema are: (1) the disturbance of the negative pressure in the pleura, (2) secondary infections. There is no doubt at all that where throughout the course of treatment of empyema it is possible to exclude these two factors, the chronicity of this condition will be very much shortened. In addition it would preclude the necessity for the occasional subsequent radical operations.

In an attempt to perfect a method of continuous drainage for this condition, and at the same time to exclude atmospheric pressure and secondary infections, I have devised a special cannula which is practically non-obstructible, with which one can drain the pleura, through an intercostal space, into an air-tight receptacle. Special provision is made for the attachment of a suction pump and a negative pressure manometer (see Fig. 1). This makes it possible to maintain any desired negative pressure in the pleural sac while draining it.

The advantages of such an apparatus are apparent and numerous. The control over the negative pressure, throughout the treatment, assures against primary collapse of the lung, and its coincident grave dangers. It also affords a means of keeping the lung expanded automatically, thus promoting early adhesions between the pleura and preventing the formation of a dead space. The non-obstructible cannula, which is a trochar cannula convertible into a cannula with a hidden curette, assures ample drainage and obviates rib-resection or other operative procedures (Figs. 2 and 3). With this method the original dressing is the only one, so that secondary infection from extraneous sources is practically impossible. The mussy, obnoxious dressings that we are all familiar with are entirely done away with as all the pus accumulates in the receptacle (Fig. 5). The entire procedure tends to shorten the duration of the treatment and affords a method which is scientific, sanitary, pleasing, and simple. The truth of the preceding statements is well illustrated by the following preliminary report of a few cases treated with this method.

Before citing the case histories, I shall very briefly describe the apparatus, so that reference to it in the histories will be clearly understood. It consists essentially of four parts: (1) a special cannula with a suction cup to hold it to the chest-wall; (2) an air-tight receptacle; (3) a negative pressure manometer; (4) a suction pump (Figs. 1, 2, 3, 4). These parts are connected by thick rubber tubing, so as to make an absolutely air-tight system, when connected to the pleural sac. The special cannula is so constructed as to be used as a trochar cannula for the thoracotomy, after which the cannula being left *in situ* the trochar portion can be converted into a curette

[1] Read before the Surgical Division, Academy of Medicine, New York City, April 7, 1916.

and used to cleanse the cannula when necessary without removing it from the chest wall (Figs. 2 and 3). This change from a trochar to a curette is accomplished without any leakage of air through the cannula. The cannula is held tight to the chest-wall with a rubber suction cup through which it projects into the thorax, sufficiently far to have the orifice of the cannula flush with the parietal pleura. This is to preclude any possibility of traumatizing the lung or visceral pleura with the rigid metal cannula. The cannula is connected by heavy rubber tubing to the receptacle, in this case a glass bottle, with a two-hole rubber stopper. An indicator is suspended at the orifice of the inlet into the bottle, and if the cannula is not obstructed, it will move with every act of respiration. Should the indicator be immobile it would mean that the curette should be used and the cannula cleaned. Some more rubber tubing connects the receptacle to a negative pressure manometer and a suction pump which are both detachable (Fig. 5).

Before the apparatus is applied, a preliminary puncture is made to determine the thickness of the chest-wall. This is done as follows: An aspirating needle with syringe attached is inserted just beneath the skin, and a vacuum is produced in the syringe by withdrawing the plunger. The needle is now very slowly introduced into the thorax. When the first drop of pus appears in the syringe, the point where the needle disappears into the skin is marked off. The distance from this point to the tip of the needle is equal to the thickness of the chest-wall, and is the length desired for the cannula to project from the proximal surface of the suction cup. Having adjusted the cannula within the suction cup, the proximal surface of the latter is covered with a thin layer of vaseline. A clamp is placed on the tubing just distal to the cannula. The trochar-cannula is now thrust through an intercostal space, the suction cup is made to approximate the chest-wall, and its rim is sealed to the skin with a collodion cotton dressing. A negative pressure of 10 millimeters of mercury is established in the receptacle and tubing up to the clamp distal to the cannula. After the cannula has been securely fastened into the chest-wall, the clamp is released, and drainage starts without any change in pressure. The subsequent treatment, as long as the apparatus is on, consists of attaching the manometer and suction pump every day or every other day, to produce the desired negative pressure, and using the curette when the cannula is obstructed.

Fig. 1. Shows the complete apparatus attached to the patient with the pus draining automatically into the receptacle.

Case 1, on the service of Dr. H. M. Silver at Gouverneur Hospital. G. N., age 3. Family and past history negative. *Present illness*: Three weeks prior to admission to the hospital, patient was taken ill with high fever, cough and labored respirations. The condition lasted for one week, when the child suddenly became very much improved. For one week after the child appeared to be quite free from all symptoms, when she gradually became ill again, with fever and continuous cough. Her condition became worse until her admission to the hospital.

Physical examination on admission to the hospital on February 3, 1916 showed an anæmic and very poorly nourished child, flushed and coughing incessantly. The physical signs of the chest were those of fluid in the right pleura; i.e., expansion was much diminished in the right side; vocal fremitus, breath and voice sounds were entirely gone from the right side, anteriorly and posteriorly. The heart apex was displaced to three inches from the left border of the sternum, in the fifth space. An exploratory puncture was done in the eighth space in the mid-scapular line, and about 10 cubic centimeters of thick creamy pus was aspirated. Smear and culture from the pus showed only pneumococcus.

X-ray on February 7 showed a dense shadow occupying the entire right side of the thorax and the heart displaced slightly to the left (Fig. 6). Temperature 102.5°, respiration 30, pulse 130. On February 10 the apparatus was applied. A negative pressure of 10 millimeters of mercury was established throughout the tubing and receptacle before the drainage was permitted to start. After the cannula was securely fastened to the chest-wall and the connection made air tight, a clamp on the tubing distal to the cannula was released and the drainage of pus, from pleura to receptacle, was established and continued automatically without any change in pressure.

On February 11, the manometer was attached, and the negative pressure decreased to 20 millimeters of mercury. Considerable fibropurulent discharge had accumulated in the receptacle. The indicator was moving with every respiratory action. On February 13, the indicator was motionless. The cannula was cleansed with the curette without disturbing the dressing or the negative pressure, after which the indicator was seen to move again with every respiratory motion. The temperature was normal, and condition very much improved. February 14, draining considerably. Pressure maintained at 20 millimeters of mercury. February 16, cannula obstructed, cleansed

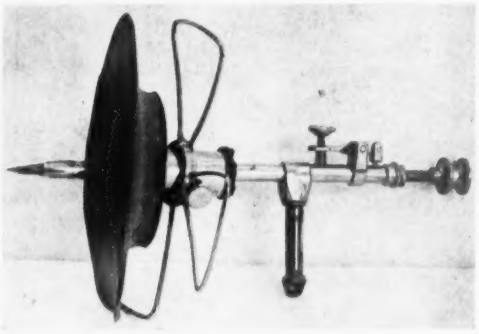

Fig. 2. Shows the cannula with the trochar tip projecting from the cannula orifice, the position for insertion. The rubber suction cup and the wire net are shown in position on the cannula.

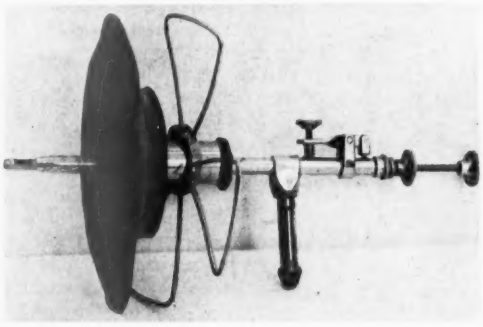

Fig. 3. The curette is seen projecting from the cannula orifice showing how the cannula can be cleaned while projecting into the pleural sac.

with the curette, and drainage re-established. Pressure changed to 30 millimeters. February 21, draining freely. Rise in temperature to 104°. Respirations rapid and labored. Considerable cough. Tubular breathing at right apex. February 24, physical signs of consolidation gone from the right apex. X-ray shows the lung to be completely expanded, and the visceral and parietal pleuras in apposition (Fig. 7). Breath sounds are audible throughout the right chest. Temperature 101°, respiration, 34, pulse 130. The apparatus was removed. Small rubber tube drain inserted through the depth of the chest-wall.

The pleural sac had been drained continuously for two weeks, with a constant pressure of from 10 to 30 millimeters of mercury. At the time the apparatus was removed, the condition was practically eradicated as confirmed by X-ray and physical signs, in spite of the continued high temperature. For two days after the removal of the apparatus, a very small quantity of pus stained the dressings, after which it ceased entirely. Up to March 6, the patient's condition remained the same, that is, although cured of the empyema, she still suffered from a wandering pneumonia. Her temperature remained high, at about 103 to 104°, with rapid respirations and rapid pulse. On February 29, she developed tubular breathing and moist rales in the apex of the left axilla. These signs persisted until March 6, when her temperature came down to normal, and the child became apparently well, although very weak. Repeated sputa examinations during this time failed to show the presence of tubercle

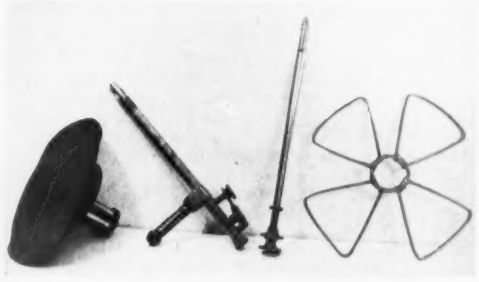

Fig. 4. Shows the rubber suction cup, the cannula, the double rod which engages the trochar or curette, and the wire net for reinforcing the suction cup. The position of the thumb screws on the rods determines whether the trochar or the curette will project from the cannula orifice (see Figs. 2 and 3).

Fig. 5. Shows a patient in whom the cannula has been *in situ* for 5 days. Dressing clean, and pus draining into the receptacle, with a negative pressure of 30 millimeters of mercury, throughout pleura tubing and bottle.

Fig. 6. CASE 1, before the apparatus was applied.

Fig. 7. CASE 1, 13 days after the treatment was started.

bacilli. Von Pirquet reaction was slightly positive. Here was a child in very poor physical condition who had she been compelled to combat, in addition to a severe wandering pneumonia, the respiratory embarrassment and toxæmia of secondary infection which usually follow other methods of treatment of such a condition, would, if I may venture my opinion, undoubtedly have succumbed to her ailments.

In this case, the apparatus had been applied for 13 days. Drainage ceased entirely in 16 days. The first dressing was the only one as long as the apparatus was applied, and there were but three dressings subsequently. One liter and a half of fibropurulent discharge accumulated in the receptacle.

CASE 2, on the service of Dr. John F. Erdmann, at Gouverneur Hospital. P. D., male. Family and previous history negative. Always enjoyed good health. Venereal history denied. On February 18, the patient was admitted to the hospital, suffering from a penetrating stab wound of the right chest. Interstitial emphysema was absent. The wound was situated two inches to the inner side of the lower angle of the right scapula, and was three-fourths inch in length. The wound was thoroughly iodized, but not probed, and the chest strapped. Seven days later, the patient was discharged from the hospital apparently cured. Four days later, the patient was readmitted to the hospital, with high fever, decided dyspnœa, and complaining of very severe pain in the right chest.

Physical examination on admission, March 1, showed a young man, well nourished, perspiring freely, in a high fever, and very short of breath. Further examination negative, except for the chest. The heart apex was pushed over to the left, four and one-half inches from the sternum. The entire right side of the chest, front and back, was flat on percussion and breath and voice sounds were entirely absent. Respiratory motion was entirely abolished on the right side. Temperature 104°, respiration 38, pulse 120.

X-ray of the thorax, on the next day, showed the entire right side of the chest to be occupied by a dense shadow, and the heart shadow to be displaced to the left (Fig. 8). An exploratory puncture produced 10 cubic centimeters moderately thick pus which showed short chain streptococci in pure culture.

The apparatus was applied, and a negative pressure of 20 millimeters was produced throughout the entire apparatus before drainage was permitted to start. The canula was obstructed on the third day, and was cleansed with the curette, without disturbing the dressing or the negative pressure. The pressure was decreased to 30 millimeters the next day.

X-ray on the fifth day showed complete obliteration of the pleural sac (Fig. 9). The right lung was completely expanded with the heart restored to its normal position.

Fig. 8. CASE 2, before the treatment was instituted.

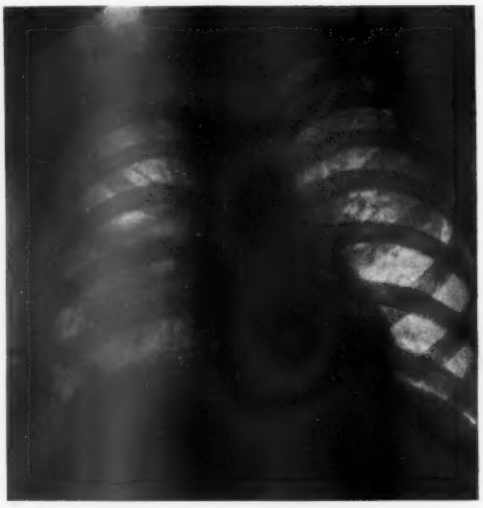

Fig. 9. CASE 2, on the fifth day of the treatment.

Breath sounds were completely restored over the entire right side, and the heart apex sounds were in the normal position. Two days later the patient was up and around the ward. The cannula was connected to a very small bottle which he carried in the pocket of his bath robe. Two days later, the ninth day, the apparatus was removed. A culture taken from the sinus of the wound, immediately after the removal of the cannula showed only short chain streptococci, demonstrating the exclusion of secondary infection in this case by this method of treatment. The dressings were slightly stained for the next three days after which the drainage ceased entirely.

During the 9 days of the application of the apparatus, a continuous pressure of 10 to 30 millimeters of mercury was maintained. During this time 2¾ liters of fibro-purulent discharge accumulated in the receptacle. The patient was up and around the ward at the end of a week, with the apparatus attached and working. Secondary infection was excluded.

CASE 3. S. L., female, 2 years old, on the service of Dr. J. F. Erdmann at Gouverneur Hospital. At the time of the writing of this article, this patient had been treated for only five days, so that I rather hesitate to quote her history with the others. However, owing to the gratifying results as demonstrated by the X-ray checking up of the treatment, I feel that I ought to describe the case briefly as far as the treatment has gone.

The empyema was postpneumonic and about 10 days old at the time the apparatus was applied. Temperature 101, pulse 130, respiration 40. preliminary exploratory puncture produced thick, creamy, yellow pus, organism pneumococcus in pure culture. X-ray on April 1, showed an extensive empyema on the left side, with displacement of the heart to the right (Fig. 10). Physical signs were those of marked pleural effusion on the left side, with displacement of the heart inward. The apparatus was applied on April 2, and a negative pressure of 20 millimeters was established and maintained continuously, until the third day when it was changed to 30 millimeters. X-ray on the fourth day shows nearly if not complete obliteration of the pleural sac by expanded lung, and the position of the heart nearer that of normal. (Fig. 11). Breath sounds were audible over the entire left pulmonary area. The writing of the report, at this time, prevents quoting the case further. However, reference to the X-ray photographs supplements the curtailed history adequately.

In conclusion I would enumerate the advantages of this method of treatment.

1. It materially shortens the duration of the condition.

2. It makes cutting operative procedures unnecessary.

3. It maintains a continuous negative pressure in the pleura, while the latter is being drained, thus promoting early adhesions, preventing any possible primary collapse of the lung, and preventing also the formation of a dead space.

4. It excludes secondary infections.

5. It affords a clean, sanitary, and pleasant method of getting rid of the pus. No dressings are necessary, as long as the apparatus is attached, and very few subsequently.

6. The method can be used in ambulating cases.

Special attention should be called to the desirability of this method and its advantages, in the treatment of empyema in infancy and early childhood. Here, operative procedures, respiratory embarrassment from disturbances in the pleural pressure, increased toxæmia from second-

Fig. 10. CASE 3, before the apparatus was applied.

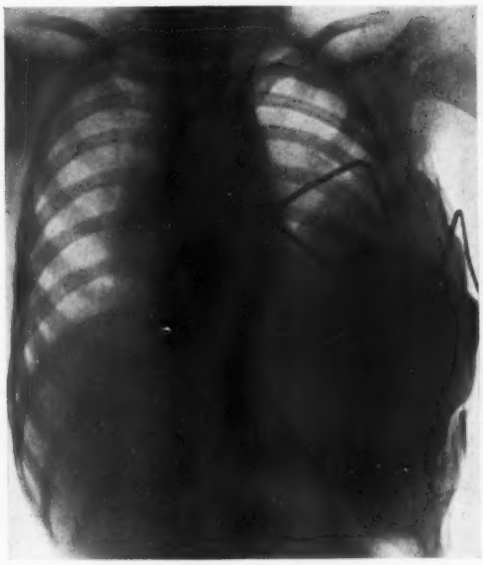

Fig. 11. CASE 3, on the fourth day of treatment.

ary infections, are all contributory factors to the high mortality of this condition, in the weakly constituted little ones. It is most probable that with the numerous advantages it presents, this method will lower the high mortality very considerably. This method should also find a special field of usefulness, in the treatment of hydrothoraces. Here the displacement of heart and mediastinum make the treatment exceedingly dangerous at times, because of the change of intrapleural pressure coincident with the procedure. With this method, the closest to the normal physiological condition can be preserved, while the fluid is permitted to drain automatically from the pleural sac.

Your attention is called to the accompanying roentgenographs, which demonstrate conclusively the efficiency of this method. Figure 6 represents the empyema present in Case 1, before the apparatus was applied. Figure 7 shows the same patient 13 days later with the intrathoracic condition restored almost to normal. Figure 8 shows Case 2 before the treatment was instituted, and Figure 9 shows the same patient 5 days later, with the pulmonary condition restored to normal. Figure 10 shows Case 3 before the apparatus was attached, and Figure 11 shows the same patient 4 days later with the condition almost cleared up. (The light shadow in the lower and outer angle of the left pleural sac, is thrown by the rubber suction cup and not by anything in the pleural sac.)

I fully believe, that with an early diagnosis of empyema and the immediate institution of a method of treatment which presents the advantages enumerated previously, we have an absolute prophylactic to the pathological condition which we all dread, i.e., an extensive fibrinous exudate, a contracted lung, and a big dead space secreting endless pus. Quick diagnosis and treatment of the condition should preclude the necessity for extensive rib-resection operations, lung decortication, and other operative procedures.

Opportunity is here taken to extend my sincerest thanks and appreciation to Drs. John F. Erdmann and H. M. Silver for their very helpful encouragement, and for the courtesy of allowing me to treat with this new method these cases on their services.

# A LIQUID HEAT APPARATUS TO SUPPLANT THE ELECTRIC CAUTERY USED BY PERCY[1]

By J. TATE MASON, M.D., Seattle, Washington

IN 1905, Haaland, in attempting to obtain artificial purification of mixed tumors, following the suggestion of P. Erlich, showed the susceptibility of inoculable material to heat of 112°F. for half an hour; Erlich's suggestion being that, with higher temperatures, fewer and fewer cells survive. Haaland likewise showed that carcinoma will succumb before sarcoma. Clowes demonstrated the death of all tumor-cells exposed to a temperature of 113°F. and called attention to the fact that weak strains of tumors increase in virulence when incubated at from 101° to 105°F., while the opposite is true of strong strains.

Jansen has placed the vulnerability of cancer-cells at 116.6°F. for five minutes. Lambert has pointed out that temperatures above 107.6°F. were distinctly harmful and that the degree of injury to both normal and cancer-tissue depends on the degree of temperature and time of exposure. He further states that sarcoma-cells are destroyed by exposure to 108.5°F. applied for 24 to 48 hours; 109.4°F. for 6 hours; 111.2°F. for 50 minutes; and 114.8°F. for 20 minutes; while normal connective-tissue cells survive these temperatures.

From his many experiments, Percy believes that cancer-cells are killed at about 120°F. applied for 10 minutes, while the connective-tissue cells will survive up to 140°F.

It is upon this data that Dr. Percy began and is continuing his work in cancer.

The sum and substance of it is that cancerous tissue must be heated to 120°F. or above for 10 minutes, and that under no condition should it be heated above 140°F. if we wish to protect the normal-tissue cells.

Boldt believes that a high degree of heat should first be applied, and that the low degree should be reserved principally for a second application.

If these views are to be considered, an operator must have an apparatus with which the heat can be regulated and maintained under absolute control and within a fraction of a degree throughout any operative procedure. The operator must have an apparatus that can be changed from a very low degree to a very high degree in a very short time and vice versa.

The accompanying cut is explanatory of the apparatus. A small heating plant (1) is filled with heavy oil or water. To this is attached two pieces of heavy rubber tubing. A small electric motor

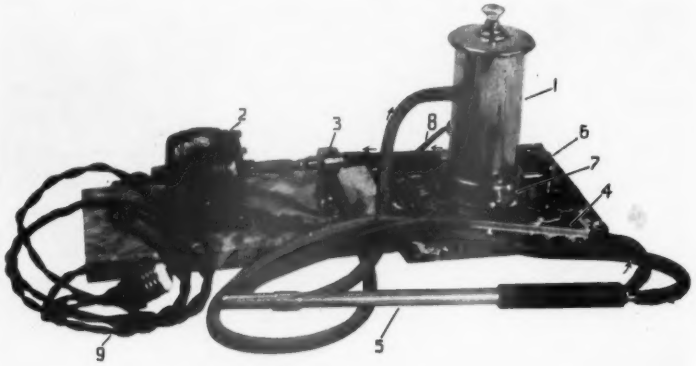


Fig. 1. 1, Heating plant; 2, motor; 3, fan, which keeps the liquid circulating, regularly; 4, thermometer; 5, heat applicator; 6, thumb screw to regulate the temperature; 7, small bulb which shows when the heating plant is working; 8, cord to the heating plant from the electric socket; and 9, cord to the motor from the electric light socket.

[1] Read before the Washington State Medical Society, July 12, 1916.

with a fan (2) is connected to the lowest tube, so that the oil can be pumped steadily through the tube into the hollow applicator (5) and back to the heating plant. As the oil (or water if the operator does not wish to go above 212°) goes back to the heating plant it runs over a thermometer (4) enclosed in a glass tube which enables the operator to see at all times the exact heat that is being applied. A thermostat is made with the heating plant which enables it to hold its heat at any given temperature, which is governed by a screw in the side (6).

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# NEW METHOD OF APPLYING AUTOGENOUS INTRAMEDULLARY BONE-TRANSPLANTS AND OF MAKING AUTOGENOUS BONE-SCREWS

By EMIL J. HOGLUND, M.D., Chicago
Assistant Orthopedic Surgeon, Rush Medical College

IN the remarkable development of bone surgery during the past few years, the most conspicuous feature is that the use of foreign material, such as steel plates, wires, nails, screws, bands, etc., has been practically abandoned. Wherever possible, every surgeon of experience now prefers to use autogenous or autoplastic methods, and this field is being rapidly developed. Intramedullary transplants, inlays, bone-pegs, and bone-screws have a wide range of usefulness, and will be universally employed, as soon as the profession has mastered the technique.

The author's electric motor saw outfit, including the rotary chain saw and automatic trephine, as presented to the profession May 7, 1913, has proved extremely useful and has attained great popularity. A new device has recently been added to facilitate the cutting of the bone in deep wounds, especially in operations upon the femur. In work of this kind the ordinary motor saw cannot be conveniently used, since the blade is placed at right angles to the long axis of the handle, and it is necessary either to use very long incisions or to sacrifice speed and accuracy. The author now presents a twin saw attachment (see Fig. 1) of small size, but high efficiency, projecting directly forward from the end of the handle, which can be used with ease at great depth.

Fig. 1. Twin saw attached to the instrument, running parallel to the handle.

### NEW OPERATION FOR FRACTURE OF LONG BONES OCCURRING ESPECIALLY NEAR THE JOINTS

The author has also devised a new operation for fractures of the long bones by which an efficient and powerful intramedullary splint can be made from the fractured bone itself and placed in position with the greatest ease and rapidity. Using for example a transverse fracture at any

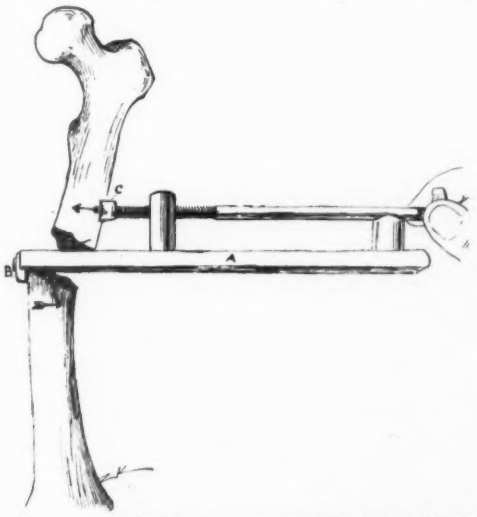


Fig. 2. Showing bar for mechanical traction, and with removable screw attachment for setting the bone fragments in line.

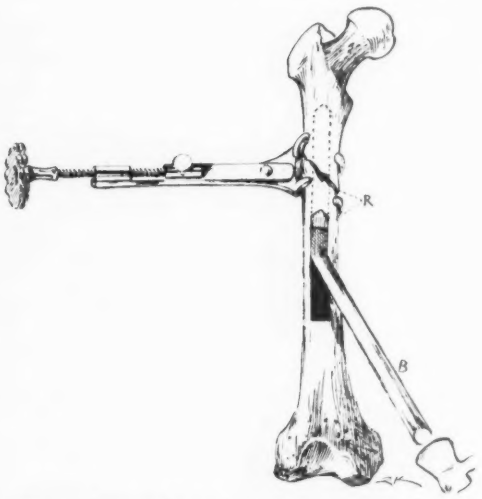


Fig. 3. Improved four-pronged swivel Loman clamp in place. It will adjust itself to the contour of the bone, and hold very firm.

part of the femur, old and ununited, the procedure is as follows:

The fractured ends are exposed, cleaned, and freshened; the sclerosed bone plugs are removed from the ends of the medullary canal in each fragment by a round burr or curette.

By manipulation (preferably mechanical traction) the overriding is corrected, and the ends are brought together by a clamp of the Schroeder type, or by the author's simple bar with screw attachment (as shown in Fig. 2), or by various other means. The ends are held in proper alignment by the clamp described above, or by my own improved four-pronged swivel Loman clamp, shown in Fig. 3.

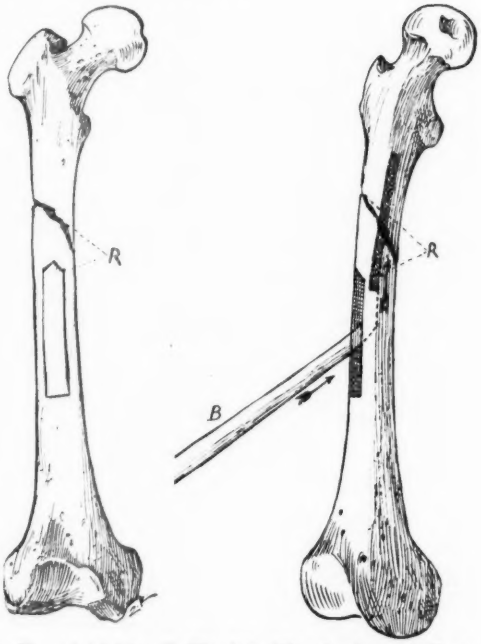


Fig. 4 (at left). *R.* The dotted lines in picture indicate the bone ring which holds the splint in place.

Fig. 5. Shows the splint driven into the bone ring, extending half and half in each fragment.

A bone-splint of a width corresponding to the diameter of the medullary canal is now cut by the twin saw; for example, from the shaft of the femur. The size of the canal should always be carefully noted before the bone fragments are placed end-to-end.

The original feature of this operation is the method of cutting the graft at a distance of about

Fig. 6. Cutting the dowel from a bone strip.

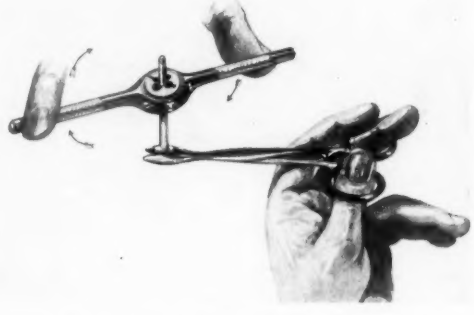

Fig. 7. Cutting the thread on the dowel.

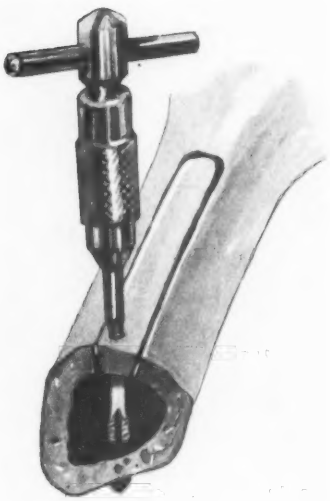

Fig. 8. Threading the holes through the inlay and opposite compact bone for the bone screw.

Fig. 9 (at left). Case 1. Fractured tibia and fibula before operation.

Fig. 10. Case 1. One month after.

one inch from the fracture, so as to leave *a complete ring of bone* (see Fig. 4, *R*) at the fracture end, thus contributing enormously to the strength of the union. The graft is, of course, cut from whichever fragment is the longer or the more easily denuded of soft tissue. In the adult femur the graft will be about a half inch wide and three inches long, depending upon the angulation of the fracture. The cutting is readily done with the twin saw, the blades being sunk at once to the full depth at the start, then being pushed along as far as needed. The ends of the graft must now be cut across, and this can be done with a thin and very sharp chisel, preferably Murphy's, or much better, by the author's small thin circular saw, which can rapidly be attached in place of the twin saw. A V-shaped cut should be made at the end nearest the fracture, and at the farther end a direct cross-cut. This leaves one end of the graft pointed (see Fig. 4).

The splint is now dislodged with the chisel (but not removed) and pressed down in the medullary canal with the pointed end toward the fracture. With a blunt tool or the special instrument shown in Fig. 3, *B*, the splint is now driven into the canal across the line of fracture, so that half of the splint will be in each fragment (Fig. 5). It will be securely held against any kind of lateral displacement by the intact ring of bone in the fragment from which the splint was removed.

This method is offered as being the easiest and fastest method yet devised, with the least handling of the bone at the operation, for applying an intramedullary autogenous bone-splint. It is much stronger than a bone-inlay, although many operators may still prefer the inlay method, for which the author's twin saw is equally well adapted. Here it has an ingenious adjustment of the saw blades by which, after the recipient groove has been cut, the blades can be separated just far enough, in cutting the graft, to make an absolutely exact fit. If this is not done the graft will be too narrow by the thickness of the saw blades. This adjustment is controlled by a set-screw fitting into drill marks on the shaft at the proper distance, one of the saws sliding along the shaft.

### AUTOGENOUS BONE-SCREWS

For holding inlays, for spiral fractures, for ununited fractures of the neck of the femur, and for fractures of the olecranon, patella, the condyles of the humerus and femur as well as of the malleoli, the author uses autogenous bone-screws, which are made from strips of bone by

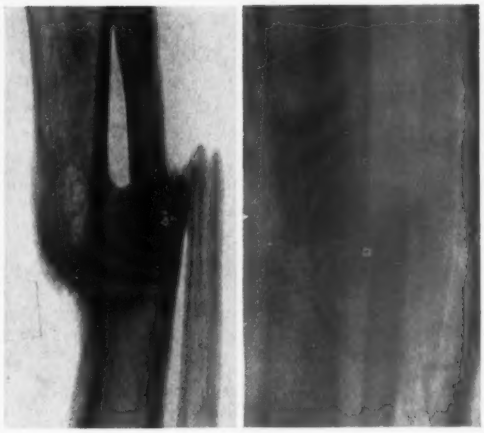

Fig. 11 (at left). Case 2. Compound fracture of tibia and fibula.
Fig. 12. About 5 weeks later.

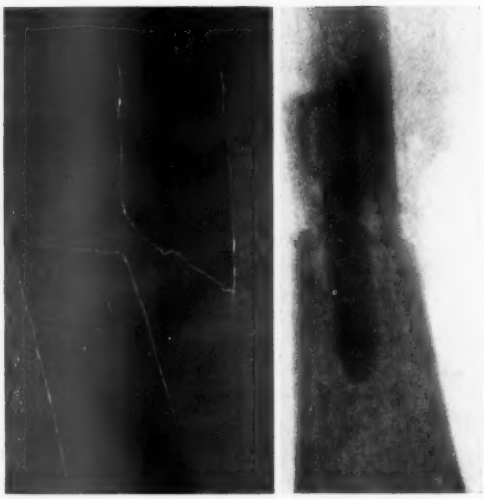

Fig. 13 (at left). Case 3. Fracture of the femur.
Fig. 14. About five weeks later.

pressing them through the dowel cutter as shown in Figure 6. Two sizes of cutters are furnished. A thread is then cut upon the dowel by means of the screw plate (Figure 7), and the recipient bone is drilled and threaded by the appropriate drill and tap (Figure 8). The advantages of the screw as compared with the peg are that the screw is certain to hold even if it be loose, and that it will hold fragments together against a lateral strain as well as against longitudinal strain; while on the other hand sometimes the drill will make the hole too large if not properly ground; that is, if one of the cutting edges on the drill is a little longer than the other, thus making the bone peg fit loosely.

It must always be remembered that the bone transplants and screws are not very strong, and that the limbs must be handled with the greatest care, while the plaster-of-Paris cast or other immobilization apparatus is being applied. Good assistants are necessary and a traction appliance or fracture table, similar to those designed by Hawley, Echols, and others, is of the greatest value.

I wish to report briefly the history of the first three cases:

Case 1. Patient, M. C., male, age 35, Illinois Central Railroad employee. Previous history unimportant, no lues or tuberculosis. On May 30, 1916, while working at pile driving on a bridge the hammer fell and hit a rail, which in turn hit his leg, causing a compound fracture of the lower third of the left tibia and fibula, with a large loose fragment. Some infection set in but after it subsided it was found that after several weeks it was ununited (see Fig. 9). Operation by above method at Illinois Central Hospital, July 19, 1916. No infection. The roentgenogram (Fig. 10), shows splint in good position, and perfect results.

Case 2. Patient, H. S., male, age 29, carpenter, previous history unimportant, no lues or tuberculosis. While working on a building January 2, 1916, a plank fell and struck his right leg, about two inches above the malleoli causing a compound fracture of the tibia and fibula. There was some infection which was treated by curettement and drainage; extension had been tried but with no success. Finally after seven months there had occurred a slight union side by side of the tibia, with a shortening of more than 2 inches (see Fig. 11). The patient entered St. Luke's Hospital July 30, 1916, and was operated on by above method; recovery prompt, except a slight sloughing of the skin, due to scar tissue. The roentgenogram, Fig. 12, taken August 5, shows splint in good position, and the legs of equal length. He left the hospital a few days later in good condition.

Case 3. Patient, J. K., male, age 24, Illinois Steel Company employee. Previous history unimportant; no lues or tuberculosis. On April 29, 1916, when riding on a crane he extended his left leg and was struck by a girder of the crane which twisted his leg around, producing fracture of the left femur about 2½ inches above the condyle, with a great deal of displacement (see Fig. 13). Tried extension but could not get the fragment in place; result, non-union. After nearly four months, on August 15, 1916, he was operated on at Illinois Steel Company Hospital by above method No infection. Roentgenogram taken September 6th (see Fig. 14) shows bones and splint in absolute position and good result.

An inquiry of December 1, 1916, about above three cases discloses good bony union and patients walking around.

I am indebted to Doctors G. G. Dowdall, S. C. Plummer, and James Burry for the use of the above cases.

# END-TO-END ANASTOMOSIS OF THE COLON

By P. LOCKHART-MUMMERY, F.R.C.S., London, England
Senior Surgeon, St. Mark's Hospital for Diseases of the Rectum, and The Queen's Hospital for Children; Consulting Surgeon for Diseases of the Bowel, City of London and Fulham Military Hospitals; Honorary Surgeon, King Edward VII's Hospital for Officers.

SOME sixteen years ago the popular method of joining different portions of the intestine in forming an anastomosis after resection was by means of some form of apparatus aided by stitching. Murphy's button, Senn's plates, Allingham's bobbin, Mayo-Robson's bobbin, and Laplace's forceps, all had their advocates, and any surgical textbook of that time contains numerous illustrations and descriptions of the method of using these appliances. Of these probably the most popular was Murphy's button, which held the field for some time owing to the ease with which it could be used. But the not infrequent fatalities which attended its use, the fact that the button was not always passed but had to be removed by operation, and the trouble from stricture due to the small size of the stoma have led to its disuse. With increased experience and improved technique surgeons soon found that plain stitching gave much better results both in time and safety, and at the present day no good surgeon would think of using any of these appliances when doing an anastomosis either of the large or small bowel.

When stitching first took the place of these mechanical appliances for joining the bowel, lateral anastomosis was used in preference to end-to-end anastomosis. At the present day lateral anastomosis is used only for the large bowel while end-to-end anastomosis is always employed for the small bowel. I propose to consider the reasons for this and to suggest that lateral anastomosis should be entirely discarded.

That there are still a considerable number of well-known surgeons who use lateral anastomosis when uniting the colon is clear from recent writings. In Sir Berkeley Moynihan's recent book on *Abdominal Operations* lateral anastomosis is given as the method of choice when dealing with the colon, although no good reasons are given for this preference. In the last edition of Cheyne and Burghard's *System of Operative Surgery* in the description of anastomosis of the colon we find the following: "Axial union, although it has often been performed, is not to be recommended. Lateral anastomosis is the preferable method." In the sixth edition of Jacobson's *Operative Surgery*, axial union is advised; but the general opinion seems to be very much in favor of side-to-side union, as evidenced by recorded cases.

A natural query is, What are the reasons which have led surgeons to adhere to lateral anastomosis of the colon after it has been entirely discarded for the small bowel? The obvious disadvantages of lateral anastomosis are: (1) It requires a much greater length of bowel for this purpose, and consequently either more extensive freeing of the colon or less extensive removal of the diseased portion as compared with axial union. This is a particularly serious disadvantage when dealing with the colon, as the amount of bowel is always strictly limited. (2) The operation takes longer to perform, as in addition to the actual anastomosis the ends of bowel have to be sealed off. (3) The subsequent anatomical condition is not a normal one, and the blind end of the proximal portion of the bowel sometimes gives trouble from dilatation and pocketing beyond the stoma; in some cases this has even led to ulceration and abscess.

The reason that axial anastomosis of the colon has not been popular is that it was found that the mortality from this operation upon the large gut was high. Whereas axial anastomosis in the small intestine was a very successful operation with a low mortality, it was found that axial anastomosis in the large intestine frequently failed, being followed either by fatal peritonitis or by the development of a fæcal fistula. It was supposed that the lack of success in anastomosis of the colon was due to the more solid nature of the contents as compared with those of the small gut, rendering the line of suture more likely to give way. It was, however, found that the lateral anastomosis was not attended by the same proportion of failures as axial union, and therefore this method has become more popular. The real reason, however, why axial union of the large intestine so frequently failed has nothing to do with the nature of the contents of the colon, but is entirely due to the blood supply of its walls. The arteries supplying the colon pass round the bowel in a circular direction from the mesentric border and are parallel to each other. There is very little anastomosis between the different vessels in the walls of the colon, although there is a

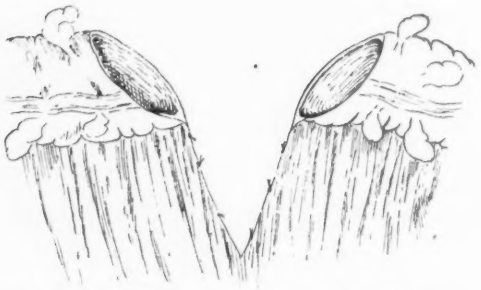

Fig. 1. The bowel is shown cut through at an angle of 45 degrees to its transverse diameter both above and below. The resected portion together with a sufficient wedge of mesentery is removed.

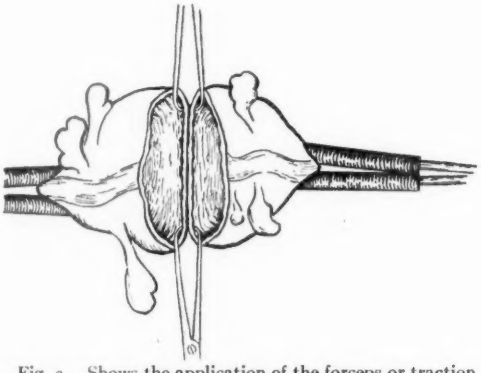

Fig. 2. Shows the application of the forceps or traction suture at the sides of the bowel halfway between the mesenteric attachment and the free border.

free anastomosis along the free edge of the mesentery. It is obvious, therefore, that if in performing a resection, the bowel is cut across transversely and sewed together in this position, there will be considerable risk of the stitches joining the edges of the bowel on the mesenteric side, constricting the vessels and so damaging the blood supply of the bowel edges on the side opposite to the mesentery. As a matter of fact when leakage occurs after axial union of the colon it will generally be found that the leakage is on the side opposite to the mesentery. The leakage is due to the sloughing of the edges of the bowel where they are stitched together, and not to inadequate or faulty suturing. In performing lateral anastomosis, there is no danger of damaging the blood supply to the sutured edges as the arteries themselves cannot be caught up in a suture. All that is necessary, however, to secure a good result in axial anastomosis is to see that the bowel is cut across at an angle of 45 degrees from the mesentery outward, that is to say that a larger amount of bowel is removed on the free than on the attached side. In this way a good blood supply is insured to the whole of the sutured edges, while it has the additional advantage of making the diameter of the lumen of the bowel rather larger than normal at the point of union, which compensates for any narrowing due to turning in of the edges. If this method of joining the colon axially is adopted, leakage from the formation of a fæcal fistula is no more likely to occur than with lateral anastomosis, or axial anastomosis of the small intestine. I have used this method for years and have had very few cases in which a perfect result was not obtained.

The operation is performed as follows: The portion of colon which it is desired to resect is drawn out of the wound, and the wound itself is thoroughly packed off with large swabs. The loop itself is then passed through a small hole cut in a towel which is placed over the whole abdomen. The mesentery is first divided and any vessels secured. A large swab is then placed beneath the bowel through the gap in the mesentery. In this way the wound and abdominal cavity are completely shut off from the area of operation. Clamps are then applied well above and below the area which it is proposed to resect, the clamps being applied in the long axis of the bowel so that the mesentery is controlled. The bowel is then cut through at an angle of 45 degrees to its transverse diameter both above and below, and the resected portion together with a sufficient wedge of mesentery is removed (see Fig. 1). If the clamps are controlling blood-vessels in the mesentery they should now be released to make sure that there is a good blood supply to the edge of the bowel at the mesenteric attachment, as if care is not taken this may be damaged in tying off the blood-vessels in the mesentery. When it has been ascertained that the blood supply is entirely satisfactory the two ends of bowel are brought into contact and caught together by two pairs of toothed forceps or, if it is preferred, by traction sutures. If there is a tendency for the mucous membrane to prolapse beyond the muscular and elastic coats, it may be trimmed off with a pair of scissors so that the three coats remain as much as possible at the same level. This makes the suturing very much easier and prevents mucous membrane from projecting between the stitches. The forceps, or traction sutures, should be applied at the sides of the bowel half-

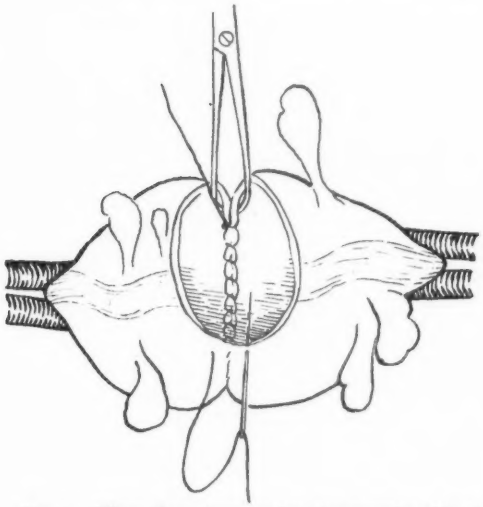

Fig. 3. When the suture reaches the opposite side of the bowel, the toothed forceps are removed and the stitch is continued around until it reaches the point where it started. It is then tied off, great care being taken to keep all knots on the inner surface of the bowel.

way between the mesenteric attachment and the free border (Fig. 2). A stitch of fine catgut, with a short straight needle, is now started from one pair of the toothed forceps and carried across to the other so as to sew the two mesenteric portions of the bowel together. This stitch should take up all the coats but should keep close to the edge so as not to endanger the blood supply. When it reaches the opposite side of the bowel, the toothed forceps are removed and the stitch is continued right round until it reaches the point where it started, where it is tied off, great care being taken to keep all knots on the inner surface of the bowel (Fig. 3). The clamps are now released so as to make sure that there is no bleeding. Should there be any, additional sutures must be inserted to control it. A fine-thread peritoneal suture is now put in, starting from the mesenteric attachment on one side and picking up the peritoneum one-sixteenth of an inch outside the first line of suture on each side. This is continued round (Fig. 4) until it meets the mesentery on the opposite side of the bowel where it is continued down the mesentery itself so as to close the gap. This completes the suturing and after the bowel has been swabbed over, the clamps and all the towels and swabs are removed, and the gut is returned to the abdomen, the abdomen then being closed in layers without drainage.

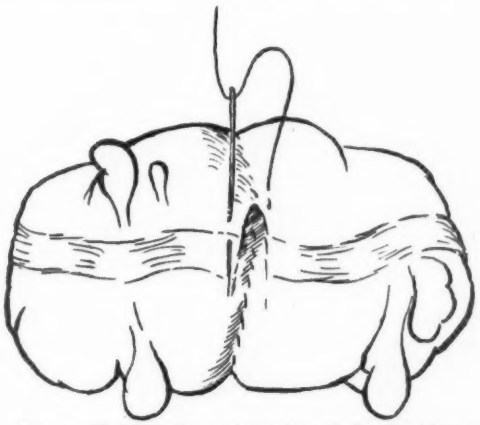

Fig. 4. Showing the continuation of the fine-thread peritoneal stitch until it meets the mesentery on the opposite side of the bowel where it is continued down the mesentery itself so as to close the gap.

That the suturing done by this method is very effective is proved by the following case:

Miss E., aged 40, was sent to me for symptoms pointing to growth in the sigmoid flexure. With the sigmoidoscope the growth could be seen, and I operated for its removal. At the operation a small growth was found in the middle of the sigmoid flexure which was causing a considerable degree of obstruction, so much so that at the operation the bowel above the growth was dilated and obviously much loaded with fæces. For certain reasons which appeared to be important it was decided to perform resection straight away, although a preliminary colotomy appeared indicated. A resection was done in the manner described above, and on releasing the upper clamp a wave of material could be seen to pass down and considerably distend the line of union. No trace of leakage occurred, however; the abdomen was closed without drainage, and the patient's bowels acted freely within an hour of the operation. Union occurred by first intention and the patient was up as soon as the wound healed.

I have now performed a considerable number of resections of the sigmoid by this method and have found it to give results which are just as satisfactory as end-to-end union of the small intestine or lateral anastomosis of the large. I have not had a single fatal result from anastomosis of the large bowel by this method and only two cases in which there was failure of primary union, and in neither of these did a fæcal fistula develop. The operation can be very quickly performed, and the method of stitching the mesenteric side of the bowel is much easier than the more usual method of starting the stitch at the mesenteric attachment, particularly where there is a considerable amount of fat in the bowel-wall and mesentery.

*After-treatment.* The bowels should be moved

on the second day by a small gruel enema, assisted if necessary by a hypodermic injection of pituitary extract, and after this the bowels are kept moving easily by some mild aperient. This is much better than leaving the bowels for some time, which often results in the formation of scybala and in the accumulation of blood and discharge in the neighborhood of the anastomosis. The patient is given an ordinary light diet consisting of chicken, fish, milk puddings, bread and butter, eggs, etc., but milk and slops should be forbidden as they tend to cause flatulence. The patient is, of course, not allowed to eat a large amount for the first few days, but only enough to satisfy hunger. Liquid petroleum by the mouth in half ounce doses three times a day is very useful in preventing the formation of scybala.

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## CORRESPONDENCE

### CHICAGO GYNECOLOGICAL SOCIETY

*To the Editor:* The Chicago Gynecological Society offers annually an award of one hundred dollars ($100.00) to the author of the best paper presented to the society during each year upon a subject concerning gynecology and obstetrics.

The paper must be read and defended before the society in an open meeting, may be of any length, but must not have been read elsewhere, and when read, shall become the property of the Society.

Any one who desires to read a paper in this competition may address the undersigned.

N. Sproat Heaney, Secretary,
104 S. Michigan Avenue, Chicago.

# TRANSACTIONS OF SOCIETIES

## CHICAGO SURGICAL SOCIETY

REGULAR MEETING HELD NOVEMBER 3, 1916, WITH THE PRESIDENT, DR. WILLIAM M. HARSHA, IN THE CHAIR

### CONGENITAL DEFORMITY OF THE FOREARM AND HAND

DR. SYLVAN KUNZ: The case I wish to present is that of a little girl who was born with a hand minus the thumb and a very rudimentary radius. The scar that you find is the result of an operation performed when she was seven months of age. What was done I do not know. The X-ray shows that some of the metacarpal bones are lacking, and the upper end of the radius, while present, is thinner and not near the normal size.

DR. KELLOGG SPEED: Are there any other bones in the body affected?

DR. KUNZ: None, and the family history is negative on the father's side, the mother's side, and the grandparents' side.

DR. C. G. BUFORD: This case offers an unusual opportunity. The congenital absence of about the lower half of the radius provides no resistence to the muscles and tendons on that side, and therefore the hand swings well to the radial side. Without doubt the deformity thus induced may be most markedly, if not completely, corrected. The soft parts should be laid open and a tibial graft placed between the lower extremity of the radius and one of the larger carpal bones on the radial side and fixed there; the wound closed and the entire extremity placed in a cast with the hand turned a little to the ulnar side. The tendons are more pliable in such cases than they appear to be, but if they should prove too short to allow the insertion of a graft long enough to correct the deformity, they may be elongated. One will be sure to get ankylosis at the wrist between the carpal bone and the graft, which is of little importance now. An arthroplasty may be done later with a fair opportunity for success.

DR. KELLOGG SPEED: This case offers unusual opportunity for bone transplantation. The child is young and apparently in good health, and a piece of bone applied to the lower end of the radius implanted in the wrist, the hand held in marked ulnar flexion until the soft parts heal, would probably take on some growth as it is exposed later on to functional use. The lower end of the radius should be freshened, the transplant very firmly imbedded by tunneling into the medullary cavity without the use of any foreign body, and the radius would grow and take on function proportionate to the amount of use the hand was given. The elbow-joint seems to be normal. The seeming dislocation of the ulna is false. The joint there is probably perfectly normal.

DR. D. B. PHEMISTER: I do not believe that from the insertion of a transplant we can hope for very much longitudinal growth. Experimentally that has been pretty well disproved, where there is an absence of epiphysis as there is in this case.

DR. C. G. BUFORD: In reference to what has been said by Dr. Phemister about the failure of tibial grafts to grow, I wish to state that about two years ago Dr. F. B. Riley exhibited plates and photographs for me at one of our meetings. I had removed the entire tibial diaphysis from this patient and had waited a good many months for regeneration, which was only partial. I finally put in a free tibial graft. It is true, elongation in this case was not great. We have no means by which we can be sure that there has been any growth. We do know that the growth was so deficient that the leg bowed and to overcome this I severed the tibia, corrected the position, leaving a gap, which I filled with a long, free tibial graft. I do not see why this cannot be done again and again as the bone grows, thus preventing an undesirable deformity.

DR. KELLOGG SPEED: The epiphysis near the elbow begins to calcify last, and if function can be started in the forearm, which would call upon the bone to develop, that epiphysis would take on increased growth in a general physiologic way. It would grow perhaps twice as large as it would normally under favorable conditions, and being the last epiphysis to unite, one might get a better looking forearm than the patient has at present.

### IMPLANTS FOR THE RADICAL CURE OF LUNG ABSCESS IN EMPYEMA

An abstract of DR. EMIL BECK'S paper as above, follows:

Dr. Beck demonstrated three cases of lung abscess from a series of seven cases, which he operated upon since 1910, by a new method which he calls "epidermization of lung cavities for the radical cure of lung abscess." He employs a principle which he has used in obliterating deep-

seated bone cavities, namely, the implanting of flaps of skin into their depth. He makes a large skin flap, removes a sufficient number of ribs in the area of the lung abscess cavity, then widens the abscess cavity and inserts the skin flap into the depth, placing it in contact with the abscess-walls, without using a single suture. Quantities of gauze are then packed against the skin, in order to keep the flap in contact with the abscess-wall. In four days the gauze packing is removed and the skin flap is usually adherent to the abscess-wall.

Should a bronchus communicate with the cavity, it is cauterized, sometimes during the operation. Care is taken that the abscess-cavity is not filled with ether fumes. This might cause an explosion. The ether is discontinued for a few minutes and the patient given oxygen. Then the mucous membrane of the bronchial opening is destroyed by means of the actual cautery.

Further epidermization of the exposed abscess surface is produced by pasting strips of adhesive plaster covering the edges of the skin flap. This procedure is very simple and produces a most rapid growth of the epidermis from the edges of the implanted skin, gradually covering the entire surface of the granulating surface. Thus the abscess-cavity is gradually transformed into a surface covered with skin; in other words, the interior of the abscess-cavity is transformed into body surface. After a time there remains in some cases a funnel-shaped depression of the skin; in others the depression has gradually become less shallow and is nearly level with the body surface.

This report is not intended to demonstrate a perfect method of closing all abscess-cavities, but each successive case, with improvement of technique, has brought the author nearer to the solution of this most difficult problem, namely, the obliteration of long suppurating abscess-cavities and empyemata with communication of bronchial fistula.

The operation is intended only for cases which do not heal spontaneously or in which the bismuth paste has been tried without result. The series of seven cases reported consists of patients who have had these fistulæ for as long as twenty years and in some instances the cavities contained as many as seven bronchial openings.

The author believes that the perfection of this method will eventually lead to the abolition of such mutilating operations as the Schede and Estlander or decortication of the lung.

### DISCUSSION

Dr. H. M. Richter: I would like to ask Dr. Beck whether he has any ground for limiting the resection of the ribs to three or four or five?

I had the opportunity two years ago, before the war broke out, of seeing several men abroad doing this kind of work, among them Sauerbruch, who operated on two or three cases, and I saw approximately forty of the patients upon whom he had operated. Sauerbruch makes it a point to remove eleven ribs. He says the removal of the first and second ribs is essential; that one is not justified in leaving the first and second ribs behind. I saw Wilms remove five or six ribs, and he left the first and second ribs, but the general trend up to two years ago was to remove all but the last rib which is so short and mobile that it does not prevent collapse. The operators made a long flap of soft tissues over the ribs, including the entire side of the chest. They made a horseshoe-shaped flap or a fishhook-shaped flap. They began up high behind the inner border of the scapula, extended the incision down to the eleventh or twelfth rib, and then curved forward and upward, turning out and resecting eleven ribs without opening the pleura, then allowed the entire lung to collapse and the soft tissues to fill in with it without drainage. By doing such a resection the operation was no more severe. I saw Sauerbruch remove eleven ribs under local anæsthesia and complete the operation, including the suturing of the flap, in less then fifteen minutes. The patient presented no evidence of shock.

Dr. Emil Beck (closing): Answering the question of Dr. Richter, I will say Professor Sauerbruch employs his operation in cases of tuberculosis. He resects a large number of ribs and allows the chest-wall to fall in and sutures the skin wound. I do not suture the skin at all. I cut large sized flaps of skin, invert them into the chest-cavity over the edges of the resected ribs and allow them to heal in, thus converting the cavity in the lung (whether it be an abscess-cavity or an old empyema) into the outside, so to say. I need not resect more than three or four, and seldom five or six ribs, depending upon the size of the cavity. I object to resecting the entire twelve ribs on one side, for the reason that there will be considerable deformity after the operation, while with this method there is practically no deformity. When the patient is dressed no one can see any defect in his chest-wall. I leave as much as possible of the posterior part of the rib to maintain the erect position of the patient. The cut edges of the rib will in time unite by bony union without obliteration of the intercostal spaces.

This operation I believe will in time be a substitute for the more serious operation of resection of the chest-wall, such as the Estlander and Schede operations. The mortality in my series is practically nothing, only one case out of eight having died, and that one from the effects of the anæsthesia.

Dr. James T. Case gave a talk on "Some Fundamentals in the Interpretation of Intestinal Roentgen Findings," which was accompanied by numerous lantern slides.

# BOOK REVIEWS

## A CRITIQUE OF NEW BOOKS IN SURGERY

Medical men are notoriously inept in many of the ordinary accomplishments of everyday life. A few, clever with tongue and pen, write books, and — book reviews. Of these few have written more interestingly than Dr. Seelig, whose book reviews in the past few years have illuminated the closing pages of successive numbers of this journal. It is with trepidation that we venture temporarily to fill the space he has occupied so gracefully heretofore.

MEDICAL Chicago had an articulate voice which will ring in the ears of the present generation for years to come. The last numbers of the *Clinics* of John B. Murphy[1] serve only to emphasize how broad was the scope of his work and how fruitful his researches in every branch of surgery. In the mind of the layman the name of Dr. Murphy stood for many things, some very real, some rather fanciful. To the older generation of medical men he was a pioneer, a skillful technician, and a brilliant workman. By the younger generation he will be remembered as the great teacher. To them appendicitis meant little more than typhoid fever or smallpox. They had not lived through the stirring days of its parturition and childhood, but received that heritage full-grown. So with gastro-intestinal surgery, with bone and joint surgery, and plastic operations that were marvels of ingenuity. They were all accepted as a matter of course, with little appreciation of their technical difficulty, and of the years of experiment and slow development that had gone before. But they could appreciate that dynamic personality and that fearsome voice reiterating in their ears "What's the matter with him?" and bidding them to "Listen to the story," and learn. No man who has ever been called into the pit at Mercy Hospital can read a volume of *Murphy's Clinics* without visualizing the clinic of his student days, and hearing again that high pitched voice speak the words on the written page. One of his students tells how in the summer following his graduation, far away from medical help on the shore of Lake Superior, when confronted in the middle of the night with a case of acute abdominal pain he boiled his hypodermic syringe, and how that oft-repeated warning, "Never give the patient morphine until you have made a diagnosis," rang so incessantly in his ears that he put the syringe away, and sat by the bedside until dawn, and emesis brought the patient relief.

[1] THE CLINICS OF JOHN B. MURPHY AT MERCY HOSPITAL, CHICAGO, vol. v, nos. 4 and 5, August and October, 1916. Philadelphia and London: W. B. Saunders Company, 1916.

The August and October numbers of the *Clinics* contain reports of a larger number and greater variety of cases than earlier numbers of the *Clinics*, with frequent references to similar cases reported previously. Of especial interest in the August number is a talk on ankylosis of the mandible, with a résumé of the differential diagnosis and technique of operation; a case of traumatic recurrent subluxation of the fourth lumbar vertebra, immobilized by a bone-graft after Albee's method; a talk on arthroplasty of the shoulder-joint; a new series of old injuries about the elbow-joint treated by arthroplasty; and a talk on subperitoneal streptococcic cellulitis, metastatic from the tonsils, pharynx, uterus, and upper respiratory tract.

A clinic for the Baltimore and Ohio Railway Surgeons, featuring the October number, gives a rapid résumé of a series of interesting bone and joint cases. In this talk Murphy emphasizes again the difference between the osteogenetic processes in bones immobilized by Lane plates and by bone-grafts. In the former absolute immobilization may lead to non-union by depriving the osteogenetic forces of the stimulation afforded by slight motion with consequent abundant callus formation. In the latter the irritation of motion causes fibrous tissue formation about the graft and occlusion of the haversian vessels, preventing bony union between the graft and the fractured fragments. He emphasizes anew the necessity of painstaking and prolonged after-care to insure proper results in bone and joint surgery; for example the maintenance of double abduction and extension in fractures of the neck of the femur "for at least sixteen weeks"; the absolute immobilization of the spine following implantation of an Albee bone-graft for at least ten or twelve weeks, and this followed in one case by the application of a leather jacket extending from the scapulæ to the trochanters. A talk on inguinal hernia, with a description of the technique of Andrews' operation; and a talk on suprapubic prostatectomy according to Freyer's method, are other interesting features.

To edit *Murphy's Clinics* in such a way as to systematically group his surgical teachings in one or two volumes would be an eminent service to the medical profession.

AS medical men tend to greater degrees of specialization, the same trend finds expression in medical literature. Books devoted to highly specialized fields of medicine and surgery have in-

creased rapidly in the past few years. Of such books we feel we have a right to expect a very complete and critical survey of the subject in question; that we may turn to them as to a court of last resort within the realm of their jurisdiction. Dr. Elsberg's new book[1] does not aim at so pretentious a place. He says in the preface, "The present volume is a record of personal experiences in the treatment of diseases of the spinal cord and its adnexa. . . . The attempt has been made to keep the book from extending beyond its proper limits — a consideration of the diagnosis and treatment of diseases of the spinal cord that may require surgical interference and all matter which belongs more properly to textbooks on neurology or general surgery has been given the briefest mention."

The book is well arranged. It begins with a discussion of the anatomy and physiology of the cord, the symptoms of spinal disease and methods of examination, going on to the technique of lumbar puncture, laminectomy, and rhizotomy, and finally to a discussion of specific pathological conditions of the cord and its membranes. The discussion of the anatomy of the cord and its membranes is confined chiefly to facts of surgical interest. The difference in structure of the vertebræ in different regions, the arrangement of root-bundles and direction of the nerve-trunks at different levels, and the relations of the dentate ligament to the membranes and the spinal nerves, and especially its peculiar conformation at the level of the first lumbar vertebra are clearly set forth. The diagram illustrating the relation of the segments of the cord to the vertebræ does not quite correspond to the description in the text, particularly as to the relation of the eighth cervical segment to the cervical vertebræ. A larger and more complete diagram of the cord in cross section, possibly in colors, would add to this chapter.

The skiagrams of different pathological conditions are a little disappointing; especially does one miss the absence of skiagrams following injury.

The exposure of the spinal cord by laminectomy is described at length, with numerous illustrations of instruments and the different steps of the operation. In view of the fact that the technical part of the operation has been so well illustrated, it might not have been out of place to describe a table (which is incompletely shown in one illustration), with a head rest for patients in the prone position.

Following a chapter of eleven pages on diseases and abnormalities of the spinal vessels, a comparatively rare condition, are seventeen pages on recent injuries of the cord, hardly a well balanced division of space. For the general surgeon injuries constitute the most common surgical cord lesions. It is to this chapter we fancy he would first turn in reading a textbook on surgical diseases of the cord. Of especial interest to him is the question as to what cases should be operated upon. With reference to this question the author says, in discussing the indications for laminectomy: "In recent fractures of the vertebræ with injury to the cord, laminectomy should be performed only when the patient's condition is sufficiently good and when the symptoms make it clear that the spinal cord has not been completely crushed at the level of injury. To operate upon a patient with a spinal fracture who has the symptoms of a complete crushing of the cord (except in the region of the cauda equina) is not only useless, but is sure to throw discredit upon a surgical procedure which is most valuable in the proper cases." In discussing recent injuries of the cord he says: "If the cord has been bruised it becomes swollen and bluish in color, due to œdema and to small intramedullary hæmorrhages, or to the rupture of a larger blood-vessel (hæmatomyelia). This acute œdema may cause all the symptoms of a complete transverse crush of the cord; it is of a very destructive nature and may, unless quickly relieved, result in disintegration of the cord in its transverse diameter." How then is the surgeon to distinguish between those cases in which the symptoms are due to an actual destruction of the cord, and those in which there is an acute œdema or a hæmorrhage pressing upon the cord? As Sharpe says: "Interruption of conductivity of nerve-fibers after fracture does not mean that those fibers are destroyed." Probably the only statement on which all surgeons could agree is Lejars', to the effect that the last word has not yet been said upon this subject. After all the real answer may be in Oppenheim's statement, quoted by Dr. Elsberg in discussing the mortality of laminectomy: "The dangers (of the operation) are small when done by a surgeon with the experience of Sir Victor Horsley."

The chapters on rhizotomy and cord tumors seemed to us the most interesting and complete. The technique of rhizotomy is well described and the indications for operation clearly set forth. The symptoms of cord tumors and the differential diagnosis between extradural, extramedullary, and intramedullary tumors are especially emphasized. Specimens of tumors removed from the cord are beautifully shown in several illustrations. The accompanying microscopic sections would surely have proved of interest as well. The extrusion method of removal of intramedullary tumors, first described by Elsberg and Beer in 1911, is illustrated by diagrams and reports of successful cases.

The mechanical details of the book are well executed; the illustrations are numerous and excellent. The addition of more and direct references to the literature would have added to the value of the book. To the surgeon it will prove especially valuable for the careful descriptions of the surgical pathology of cord lesions, of the anatomical considerations involved, and of the mechanical details essential for successful operative work.

S. L. KOCH.

[1] THE DIAGNOSIS AND TREATMENT OF SURGICAL DISEASES OF THE SPINAL CORD AND ITS MEMBRANES. By Charles A. Elsberg, M.D., F.A.C.S. Philadelphia and London: W. B. Saunders Company, 1916.